YOUR CONSTRUCTION AND OPERATING QRP SOURCEBOOK

QRP Quarterly

Volume 49 Number 2
Spring 2008
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Journal of the QRP Amateur Radio Club International

- Don't Wait! It's Time to Make Your Final Plans for QRP Fun at FDIM!
- KB1GMX Designs and Builds a 6M Transceiver
- Ten Little Rockmites— A Kit Building Event
- Confessions of a New QRPer, by NA7US
- Contest Results— Holiday Spirits Homebrew Sprint, Top Band Sprint, Fireside SSB Sprint, QRP ARCI VHF Contest

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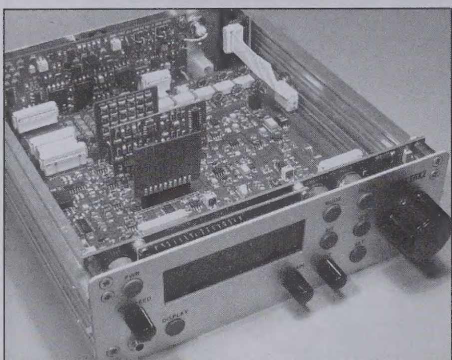

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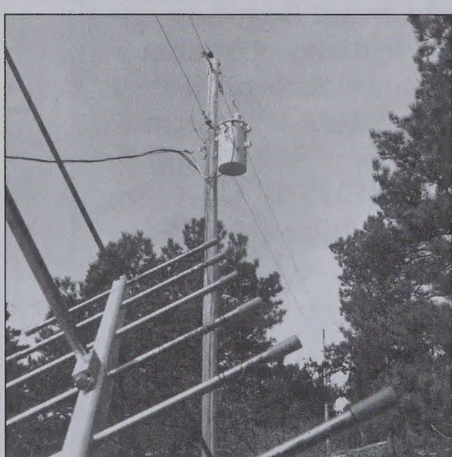

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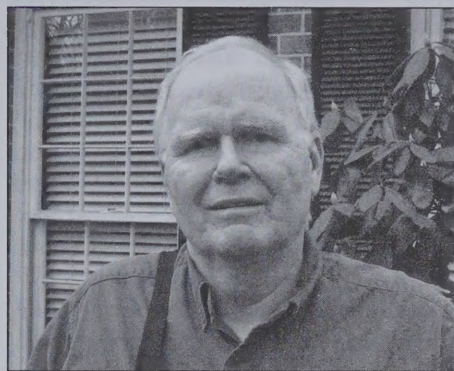
From the Editor's Desk

Ted Bruce—KX4OM editor@qrparci.org



This issue of *QRP Quarterly* is chock full of projects, projects, and more projects. Now we know what dedicated QRPers think about and do during the cold, dark days of winter. Some go solo, and some huddle together in groups. The commonly-used term for this group-building activity among hams is called a "Buildathon," and we've got reports on these events from three clubs. Scott, NE1RD provides the details on the Westford, Massachusetts Radio Club's event in the article, "Ten Little Rockmites." Great turnout, plenty of photos, and it looks like it was loads of fun! Steve, GØFUW reports on the Buildathon held in Bath, England, where they built the Walford Electronics 80m DSB rig. It's really nice when you have the designer attend to answer any questions. Darwin, W9HZC of the Midwest HBQRP Group describes how they do it "eclectic-style" …several members built the NorCal S-9 sig gen kit, there were a couple of Small Wonder Labs SW-40+ kits, and two versions of the Sudden receiver.

As to the soloists, Harold, KE6TI is familiar to us, having graced these pages with his excellent projects before. It seems that Harold's XYL was fully occupied for a weekend and left to his own designs, so to speak, Harold naturally decided that he'd just design and build a transceiver. In a weekend. Naturally, he calls the result of his effort, the "1-Weekend Radio." Amazing. Plenty of construction photos and a set of schematics are included in the article.

Jeff, K8GD's project (featured on the cover) was certainly not a weekend time-frame job, nor was it done over the past winter. Jeff's astonishing multi-band CW-SSB transceiver was the winner of the 2007 FDIM Building Competition, and one of the first things I did when I took this position last Summer was to contact Jeff about doing an article for publication in *QRP Quarterly*. Fortunately, Jeff agreed to do that, and we can all share in the enjoyment of seeing how his transceiver came together. It's not a "project," per se, but it's certainly an inspiration.

We're coming up to the Spring-Summer 6 meter season of surprises, and Allison, KB1GMX, who also is no stranger to these pages, provides Part 1 of a 6 meter QRP SSB transceiver, with block diagrams, schematics and construction photos to guide us. If you're not on six yet, here's your opportunity. Also, the second installment of Paul, WB9IPA's, 60 meter Phasing Transceiver is here. I know of one local ham near Atlanta who joined QRP ARCI and subscribed to *QRP Quarterly* because of Paul's project.

From our recent issues, many of you may recall that I'm a fan of using RG-6/U coaxial cable, because, well, I like to spend my money judiciously. And, because it offers some of the best performance that you can buy (or get for free from the cable guys working on your street). I've got Owen, VK1OD to back me up. All of the analyses, the comparisons with other cables, some tricks for putting BNC connectors on it, how to mix it in with cables of other impedances using transforming sections, it's in Owen's article.

In this issue we've also got a comprehensive review by Pete, WK8S of the JUMA high-performance, 160-10 meters phasing-type direct conversion SSB/CW QRP transceiver kit, which is the design of Matti, OH7SV and Juha, OH2NLT. This is certainly a feature-rich rig. One version, the TR2X covers 40m and 80m only, while the TR2XA covers the full amateur HF spectrum, including 100 kHz to 30 MHz receive capability.

In his VHF column, Bob, KØNR has a discussion on power line noise, and how to

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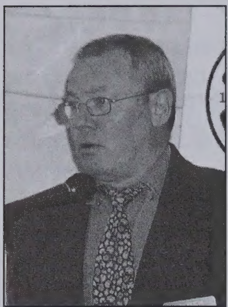
From the President

Dick Pascoe—GØBPS

president@qrparci.org



In the last issue, I mentioned my 4 ele bouncing around in the gales. Well just before Hank, Jay, etc. went off to Surinam for the ARRL DX Contest, MURPHY struck with a vengeance. The centre fibreglass part of the driven element snapped leaving it hanging by the feeder.

Now I guess many of you will know how difficult it is to lower a 60 foot fold-over tower with a 4 ele Cushcraft, a 160m doublet, a 6m and 2m beam. First you lose the doublet and then wind the tower over a touch. I then hang a couple of 56 pound weights on the bottom to make raising it up a lot easier. Of course by the time I got the replacement centre section the contest was all over. The beam is still as I write in the garden waiting for the temperature to get above 40ºF. I hate working on antennas with freezing hands!

It hasn't passed unnoticed here in the UK that there is an election going on in the US. I regularly check the news to see how Mr. Obama and Mrs. Clinton are faring. It is fascinating stuff and I relish every moment of it. Whoever wins that nomination will be a first and then still have a tough fight on their hands. It should be remembered that the UK had their first Lady Prime Minister way back in 1979! Mind you, the way we elect our first minister is different over here.

We vote for a local person who is of our preferred political party. Each political party has a leader and after the election results are declared the leader of the winning party then becomes prime minister, but not automatically. HM the Queen actually asks them to form a government but this is only a traditional thing and she cannot change whoever it is.

This means that the largest party in Westminster also makes the government and the prime minister unlike the US where the President can be a Republican and the Senate primarily Democrats. Fun isn't it.

There are also four levels of government over here in the UK. There is the Town Council which looks after everything in the town. The District Council which covers things like rubbish collection, parks etc. Then there is the County Council, which roughly equates to your State, and the next step is full Government. I am an elected official of both the local District Council and the County Council, which keeps me fairly busy each day.

During the recent Hall of Fame nominations there was apparently some confusion caused by a few individual members who sent in their vote for people such as "I want to vote for John Doe, please note my vote." Members are NOT asked to vote, only to nominate who they think is worthy of the Hall of Fame.

We take note of all the valid nominations and then the members of the Board of Directors and recent inductees to the HOF with the President and VP vote who they think should be in. The requirement is 2/3 of the votes cast. We use the recent electees to the HOF to give it some validity and not confined to club officers.

Two members are then used to act as adjudicators and count the votes. They then tell me and the VP and we get the plaques made up courtesy of Mike Czuhajewski WA8MCQ.

The ONLY people who know who are elected before the announcement are the two adjudicators, Ken W4DU, myself and Mike WA8MCQ. I just love to see the faces of the people when their name is called out. It is also not unknown for a few tears to appear!

For those that don't quite measure up to the full Hall of Fame Award there is also the Quality Recognition Program started by Jim W4QO a few years ago. This award is available for ANY member to receive and nominations can be made at any time to me or to Ken the VP.

Finally, a plea once again; The *QQ* is always looking for articles and they can be on any subject related to the hobby. It doesn't matter that you are not a great author as long as you can put your thoughts onto paper. We can edit it into a readable format if you cannot.

I well remember during my time writing for the British *Ham Radio Today* magazine and the *Practical Wireless* magazine where I had both a monthly column on QRP and a quarterly column on antennas. Each time I sat at the computer to write the article my mind went blank. It always took a few moments to get started then the verbal diarrhea kicked in and I couldn't stop. I wrote the QRP column for just over 10 years until the magazine folded in 2000.

One of those funniest things happened to me a year or so ago; I was contemplating a new antenna and after measuring the garden space available I started checking the books. I found one article especially interesting and started to build the antenna. It was only when I had finished it that I realised that I had written the article some years previously!

I put it all down to a CRAFT moment! (Can't Remember A Flipping Thing).

I want to take this opportunity to say a BIG thank you to our webmaster and latest Board member Steve Fletcher G4GXL. Steve does a wonderful job with the website and I would hate to count the hours he must spend on it. If you haven't been there yet you really MUST have a look: www.qrparci.org.

—TTFN de Dick GØBPS

FDIM SCHEDULE & HIGHLIGHTS

Wednesday May 14th—
7.30pm – 9:30pm — Registration, Challenger room. There will be tables set up for visiting with old friends or making new ones.

Thursday May 15th
7:00am — Registration will be outside the ballroom.

8:00am – 4:00pm — Seminar in the Main Ballroom. (This requires Seminar Registration). Raffle tickets will go on sale during the break.

8:30am – 5:00pm — Stitchin' in Dayton Alternate activity for the spouse in the Armstrong Room.

6:30pm — Setup display for homebrew projects (Judging on Friday Evening).

8:00pm — Meet the Authors; Show and Tell; Homebrew Display; Fun Night (Main Ballroom). This is a great opportunity to come out and visit with the Speakers from the days seminar as well as a chance to meet some avid QRPers. There will be space available to bring your favorite amateur radio items for a casual show and tell.

9:15pm — QLF contest -Send code with your left foot! (Ballroom).

10:00pm — Night Owl Surprise Contest. You gotta' be there to win (Ballroom)!

Friday May 16th
8:30am – 5:00pm — Stitchin' in Dayton (Alternate activity for the spouse in the Armstrong Room).

1:00pm – 5:00pm — Buildathon (This requires a separate registration please see the web site).

6:30pm — Setup display for homebrew projects (Judging by peers starts at 8:00).

7:00pm — An informal dialogue with the QRP ARCI Officers and Board Members. (Amphtheatre).

8.00pm — Radio Show and Tell; Meet and Greet (Ballroom).

8:00pm — Vendor Night (Vendor setup at 7.30pm; Ballroom).

8:00pm — Homebrew Display and Judging, last ballot at 9:30 (Ballroom).

Saturday May 17th
All Day—Hamvention.

8:30am – 5:00pm — Stitchin' in Dayton Alternate activity for the spouse in the Armstrong Room.

7:00pm — Awards Banquet, requires banquet registration. (Ballroom).

9:00pm — Post Banquet; Chat Session; Bring QSLs to exchange! (Ballroom).

Sunday May 18th
Hamvention and home

FDIM Seminar Speakers—

Ward Silver NØAX:
"How To Dance With The Elephants—QRP Contesting Strategy and Style"

Jay Slough K4ZLE and Jim Everly K8IKE:
"The Buildathon Project"

George Dobbs G3RJV:
"Life is too short for QRO

Mike Bryce WB8VGE:
"Emergency: Principles, Practices and Power"

Phil Harman VK6APH:
"Phasing Techniques In The Digital Age"

David Stockton GM4ZNX:
"A free Q & A session"

Feedback—Broadband Antenna and 60M Transceiver articles

Carter Rose, KD6GN, who wrote "A Broadband Antenna System for 1.8 - 30 MHz" in the Winter 2008 edition of *QRP Quarterly*, points out the following clarifications and errata in the article:

- In the section on acknowledgements (p. 31), the correct name for N7PXJ should be Clare Stadden. We regret the error.
- The asterisk (*) after the C1 values in Table 2 means "fixed values."
- The tilde symbol (~) before the C1 values in Table 2 means "approximate variable values."
- In Table 2, "160 or 80/75" should read "160 *and* 80/75." For the antenna and feedline geometry given in Figure 1 this system will adjust to a 1:1 SWR for a fixed value of 1000 pF for C1 and a maximum variable capacitance of 1000 pF for C2 over the frequency range of 1.8 to more than 4 MHz. This is the simplest and most efficient way I have seen to continuously "broadband" an antenna in this frequency range.

Also in the Winter 2008 edition of *QRP Quarterly*, the article "A Phasing Type Transceiver for the 60 Meter Band," by Paul Alexander, WB9IPA, unfortunately had several schematics that were too small to allow identification of part values. We have remedied this situation by including this material on our website, www.qrparci.org. Click on the *QRP Quarterly* menu button and navigate to this issue. Similarly detailed schematics for the continuing parts of this article will also be available online.

In the future, we expect to place complex or detailed material of this type on the website, where it can be downloaded and enlarged for easier viewing.

On the Cover—

This Month's cover features the 2007 FDIM Home Brew Contest winning entry, the ABR-1 Transceiver, designed and constructed by Jeff Hecht, K8GD. Jeff's article describing the ABR-1 begins on page 44 of this issue.

From the Editor's Desk ...continued

track it down using your ham radio gear. Bob highlights safety in the article, and one of the accompanying photos shows a typical transformer on a pole. That reminded me of an event many years ago, in my high school days. I was standing on the front porch, looking back toward the school, two streets over, and I saw a power line transformer explode, shooting a flame about 20 feet into the air for several seconds. That made an indelible impression on me regarding the energy carried in that equipment!

On the less technical side of things, Mitch, NA7US tells us what its was like when he started in QRP …in Iraq, no less. And we complain about the neighbors…

Bob, N4BP has contributed a review of three contest logging programs that cover the spectrum of host computers from DOS on a Poquet PC to Windows Vista. Oh, yes, and one key attribute …they are FREE! Yep, that got my attention, so I'll be giving them a workout and possibly abandoning my manual ARRL log. That's hard to do, after using the same process for so many years. I'll just call it "the straight key syndrome" and leave it at that.

—72 de Ted, KX4OM

Idea Exchange

Technical Tidbits for the QRPer

Mike Czuhajewsi—WA8MCQ wa8mcq@verizon.net

In this edition of the Idea Exchange:

New WA8MCQ e-mail address
Audio Amp Bounty from Consumer Products, N2CX
Staples for Antenna Radials, W5FYI
Manhattan Pad Capacitance, WAØITP, WA5BDU
Capacitor-on-a-Stick, K3NHI
Cleaning Sealed Potentiometers, Tillman, Gottlieb
20 dB Coupler, K8IQY
Fixing Cracked HP 8640B Gears, Erik Paret
Update on Pozidriv Screwdrivers, WA8MCQ
Accuracy of the Heath QM-1 Q Meter, KXØR
Transistors for Homebrew Radios, KE6TI

New WA8MCQ e-mail address! I have changed Internet providers. Readers should reach me at my new address: *wa8mcq@verizon.net*.

Audio Amp Bounty from Consumer Products (Quickie #65)

Well over a decade ago, Joe Everhart, N2CX, promised me an endless string of his Technical Quickies for this column and he's still sending them in. Joe hits another "speed limit" with his Quickie #65—

Homebrewers and QRPers have benefited greatly from consumer electronics. Manufacturers, particularly those who make semiconductors, have produced huge volumes of standardized transistors and ICs and those large volumes have resulted in very low cost components. Some examples that come quickly to mind are the MV104 and MVAM109 voltage variable capacitance diodes and the LM602, LM741, LM386 and LM78XX linear integrated circuits. Note that while the numbers above are from specific manufacturers, there are similarly numbered chips with the same basic functions from many others.

Because of this wide availability of devices, I'm always on the lookout for new consumer electronics products that are applicable to ham use directly or through reverse engineering.

Some time back Ted Groke, W2TAG, brought a cute little gadget to one of our monthly NJQRP meetings for show and tell. It was a small battery powered amplified speaker that plugged directly into a headphone jack. The intended use was with portable audio players to replace the ubiquitous earphones. Ted pointed out that it would plug directly into the headphone jack of an Elecraft KX1 or other small QRP rig which generally do not have enough audio output to drive a loudspeaker directly. At the time I thought that it was a neat idea but too rich for my blood at about $30.

As often happens with consumer gear the same basic device was eventually made by a number of off-shore production houses who drove down the price significantly. I found nearly identical products at my local Walgreens priced at two for $10, at the teeny-bopper store Five Below (can you guess their pricing policy?) initially for $5 each and again at the same Five Below for $3.00 on special sale just before Christmas. Figure 1 shows some of them with the Walgreens model on the right and the Five Below on the left. While Walgreens has only basic white and black models, Five Below also adds them in pink and pastel shades plus other form factors such as heart-shaped cases, etc.

They are quite usable right out of the box. Running on 2 AAA cells, the amp/speakers produce usable, though not room filling volume. While the fidelity is modest for enjoying music it's entirely adequate for listening to voice or CW. This is handy to eliminate the possible bother of headphones.

That's all well and good, but what dyed in the wool homebrewer can resist teardown to see what's inside? It may well be

Figure 1—Inexpensive plug-in amplified speakers.

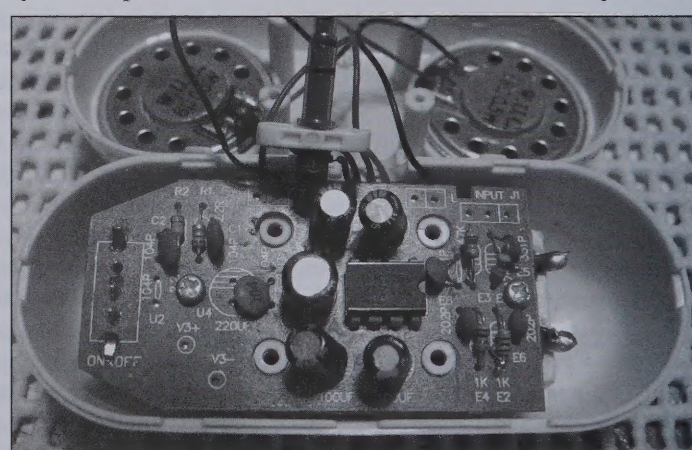


Figure 2—The simple insides of the amplified speaker.

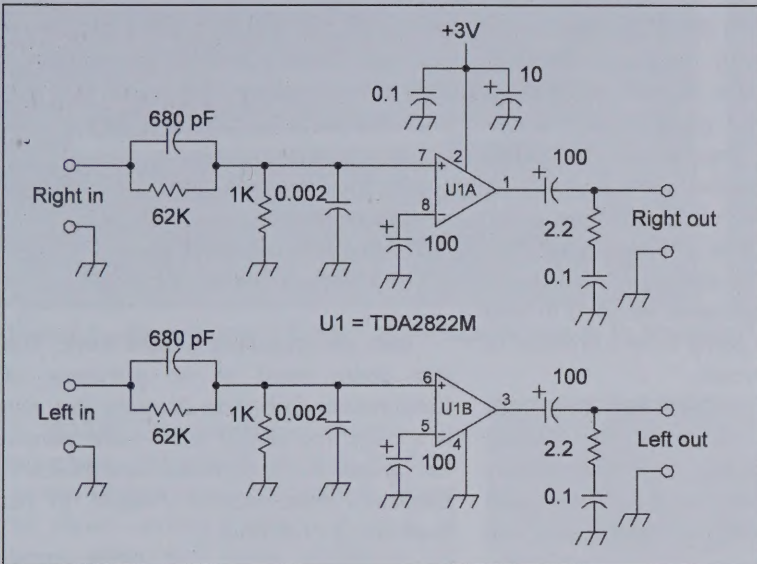


Figure 3—Stereo mini-amp/speaker schematic.

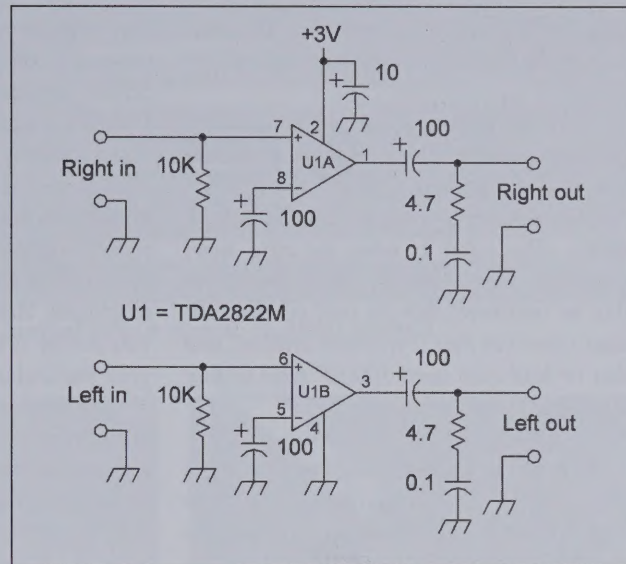


Figure 4—TDA2822M data sheet stereo amplifier.

some uninspiring chip covered by an epoxy blob like low-end calculators and watches are, or it may have some neat circuit or components inside for use in some other gadget. A real driving factor here is that the whole thing runs off only 3 volts, so perhaps ideas can be gleaned for other low voltage applications.

Figure 2 is a photo of the PC board inside one of the amplified speakers. The circuit is extremely simple, consisting of a TDA2822M integrated circuit and only a few other components driving two small speakers for the left and right stereo channels. The schematic diagram is drawn in Figure 3.

The TDA2822M chip data sheet (see Ref. 1) shows a very similar circuit, redrawn in Figure 4. There is a minor addition in the purchased amps in the form of an RC attenuator network in each audio input, apparently to prevent overdriving it.

This is the end of the line for the teardown. The only simple mod that comes to mind is the possibility of stripping out the amplifier board to incorporate it into another project (particularly if one rips the board out of one of the ugly pastel-colored girly amps).

As hoped though, the amplifier chip looks like it might be useful for other homebrew projects. It uses a fairly simple circuit and has about the same gain as the ubiquitous LM386. As anticipated, it is almost a functional "drop-in" that will work with much lower supply voltages. While the '386 will sort of work down to 5 volts, it is best at 9V or so. The '2822 is rated down to 1.8V, so it should be happy with a 3V source.

Additionally, the data sheet shows another circuit that may have some possibilities. Reproduced in Figure 5 is a monaural amp using a bridge configuration. At the possible handicap of requiring the output speaker or headphones to be floating above ground, it does away with high value electrolytic coupling capacitors.

A breadboard of the mono amp was constructed using parts scrounged from the pastel speaker/amp—there was no way I was gonna take a pink amp out on Field Day! Figure 6 shows the perf board version. The output is wired to a jack using

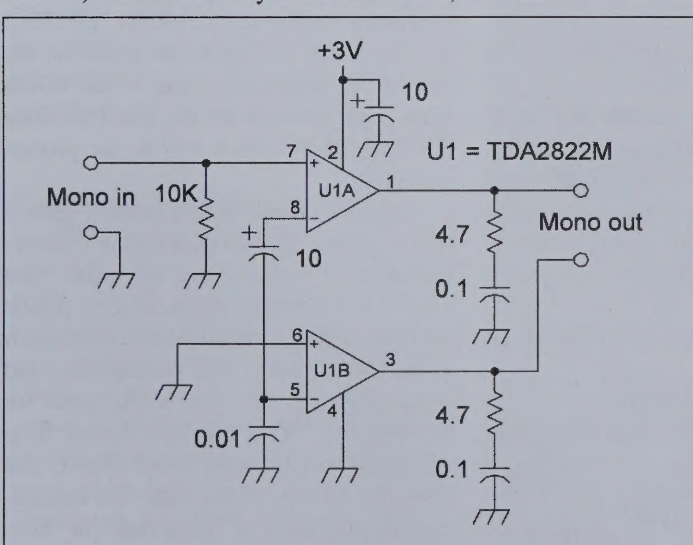


Figure 5—Datasheet monaural bridge amplifier.

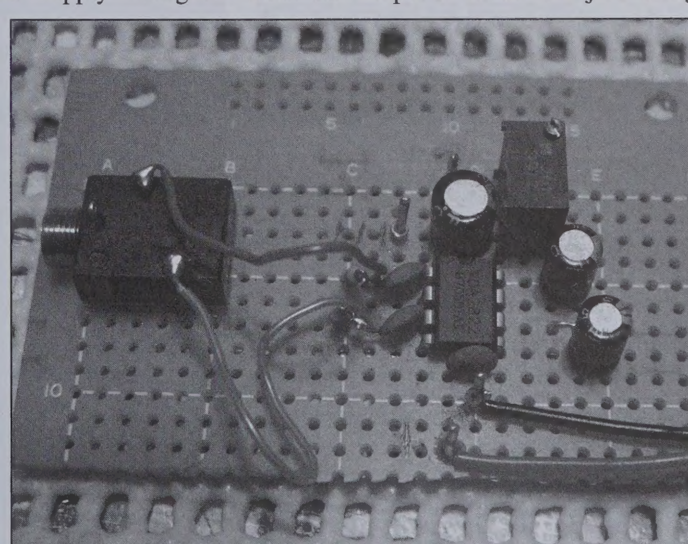


Figure 6—The mono version built with harvested parts.

only the ring and tip connections. This puts the two headphone elements in series.

[*WA8MCQ note—the photo shows 3 electrolytic caps although Figure 5 only has two. His original figure 5 had a 10 μF cap from pin 5 to ground, not the 0.1 μF shown. The latter is what the data sheet schematic has. When I asked him about this he indicated that he had misread the data sheet but that it was not critical, and that he had even used 100 μF caps in that position.*]

It works as expected at supply voltages from 3 to 9 volts and probably higher as well. [*The data sheet indicates a maximum supply voltage of 15V. —MCQ*] The gain is as specified and almost identical to a simple LM386 version. While the '2822 will drive a loudspeaker, the current drain is rather high. However, running at 4.5V into 32 ohm headphones the current consumption is less than 10 mA. I think it's a winner for my next low voltage ham project!

Reference:

TDA2822M data sheet: www.st.com/stonline/books/pdf/docs/1464.pdf

—DE N2CX

Staples for Antenna Radials

Radials are required for best efficiency with ground mounted vertical antennas. Burying them is a lot of work, and they are sometimes laid on top of the ground, held down by staples of some sort. C. H. Stewart, W5FYI, sent along this tip—

Anyone thinking of laying a radial field might want to do it before the grass in the yard starts growing vigorously this spring. A cheap staple to use is the common U-shaped hair pin. I found that the Goody brand "So Secure" pins are easy to push into the ground. The plastic blobs on the ends of the legs tend to keep the pins from pulling out of the soil. And if they do and get whacked by lawnmower blades, they're less likely to do serious damage to anything. The cost is about $2.24 per package of 100.

—DE W5FYI

Manhattan Pad Capacitance

Although the inventor, if any, is unknown, so called Manhattan construction has been around for quite a while, and was popularized in the QRP community several years ago by Jim Kortge, K8IQY. Small isolated pads are cut or punched from PCB material, glued down to a substrate, usually a large piece of unetched PCB material, and then used as solder tie points to build a circuit. The pads are either round or rectangular and very small, but there is still a finite amount of capacitance to ground. Here are some numbers to help you decide if it's going to be a problem in your particular circuit.

On one of the QRP mail reflectors, Nick Kennedy, WA5BDU, mentioned capacitance of thin pads to ground. Talking about an assortment of Manhattan pads bought from a QRP supplier, he said, "...a lot of them were made from very thin copper clad material which makes me a little nervous about the increased capacitance to ground if we're talking high frequencies."

Terry Fletcher, WAØITP, did some experimenting with pads of various sizes and replied with this—

The ubiquitous cyanoacrylate glue was employed [to mount them]. I soldered 1" component leads on the pads to add realism. I measured them with my AADE L/C IIB Meter, carefully zeroed between readings, and also my "imitation Mitutoyo" digital calipers. Here are some pad sizes vs. capacitance:

Diameter	Thickness	pF
1/4"	0.030"	1.40
1/4"	0.011"	4.31
1/4"	0.064"	0.70
3/16"	0.030"	1.27

Rectangle, 0.190" x 0.290" x 0.050" = 1.14 pF.

It's a pretty small sample size from which to draw inferences, but this is physics, not statistics. It looks like pad capacitance is inversely proportional to the dielectric thickness; no surprise there. (Man, those thick ones are tough to punch out.)

—DE WAØITP

WA5BDU responded with this—

Great minds think (and act) alike. I did some measurements too, and they look a lot like yours. I measured big pieces with my AADE meter, figured the capacitance per square inch, and used that to calculate pF per 0.25 inch pad. I had one sample that was paper thin though, which I don't think you had. That's where the pF per square inch really skyrockets. My results in pF per 0.25 inch pad:

- 1.08 for 3/64 inch thick material with white insulation
- 0.94 for 1/16 inch thick glass epoxy
- 11.1 for super thin flexible board

And yes, punching is hard work. You just about need to be governor of California to do it. And clamping in a vise is a must. [*WA8MCQ note—many people use inexpensive sheet metal hand punches, frequently from Harbor Freight, to cut pads out of PCB stock.*]

—DE WA5BDU

Capacitor-on-a-Stick

Sometimes when building it can be helpful to insert additional capacitance into a circuit to see what difference it makes or try a number of values to determine the optimum one. Bob Kopski, K3NHI, posted this excellent idea to the EMRFD discussion forum on yahoogroups.com. It's a variation on something I've seen at work for years, although we do it with surface mount parts, not leaded parts like Bob uses. It makes it very quick and easy to do without soldering. When he gave me permission to use his posting he also sent along some additional photos which are included here. *—MCQ.*

Very often I find it desirable to temporarily "probe in" capacitance on a circuit breadboard or assembly. Over the decades I've come to rely on homebrew "pF Stix," a broad range of capacitors glued on the end of an insulating probe. I use values from 1 pF through 10 μF, and I've done this both in the shack and in the professional lab.

Figure 7 shows what I mean, Figure 8 shows a close up view and Figure 9 shows one in use. I've found that the "stick" part can be wood dowel, plastic rod, or plastic tubing and that it's best to cut a small notch in the end to "nest" both the capacitor and some adhesive. Hot glue works great for this purpose. Often the local hobby shop will have various sized wood dowels and telescopic plastic tubing under the application nomenclature of "push rods" or "control rods."

—DE K3NHI

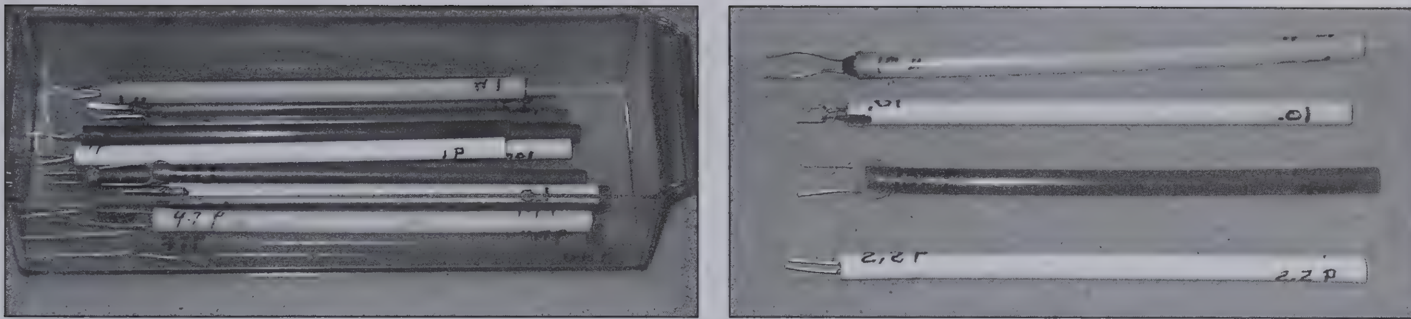


Figure 7—Homebrew "pF Stix" allow capacitance to be temporarily probed in to a circuit. (K3NHI photo.)

WA8MCQ comments—I've seen the same basic idea at work for years, but there we use surface mount components. Figure 10 shows several examples I made at home, using both round toothpicks and double ended cotton swabs from a drug store. One end is cut off flush and a component is glued on with a dab of 5 minute epoxy or your favorite adhesive. After curing, scrape off any that got on the end metallization of the components; you don't want them to be insulated. The cotton was removed from the other ends of the swabs. The pointed end of the toothpicks were left intact, to maximize the length. The masking tape label covers them up and keeps fingers from being punctured accidentally.

At work we use industrial grade cotton swabs, single ended with wooden shafts which are over twice as long as the toothpicks. The cotton at the end is cut off. Although we mostly use surface mount capacitors, other parts can be used such as inductors and resistors, as shown in the close-up in Figure 11. Capacitor-on-a-stick kits are also available commercially, from American Technical Ceramics and possibly others. They call them Tuning Sticks, a copyrighted name, and are available in a variety of types and capacitances.

—DE WA8MCQ

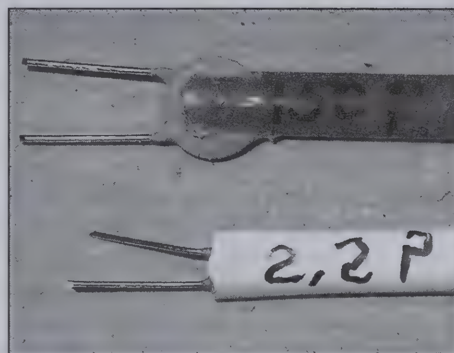


Figure 8—Depending on sizes involved, parts can be glued into a notch cut in the end of the stick or inserted into the end. (K3NHI photo.)

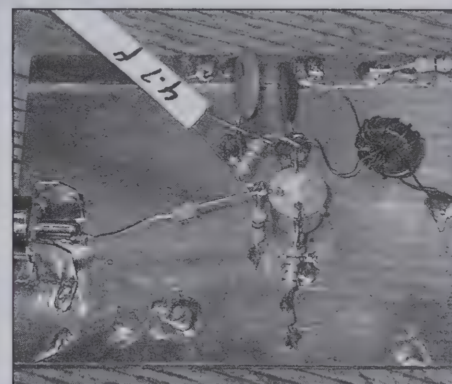


Figure 9—A capacitor is temporarily connected into a circuit, with no soldering required. (K3NHI photo.)

Cleaning Sealed Potentiometers

When a potentiometer becomes noisy you can either replace it or try shooting some contact cleaner inside and hope it helps. Unfortunately some pots are sealed and seemingly impossible to spray into. Here's a discussion on the subject that appeared on the TekScopes discussion list at yahoogroups.com. (This forum was set up a while back as an alternative to the TekScopes list there, when a number of people became disgruntled at some of the things going on. Those who frequent a number of mail lists have probably seen this scenario play out elsewhere.)

From Dennis Tillman, with the subject line "Noise in sealed pots"—

Most, if not all, of the pots in the Tektronix test equipment I have (7000 and TM500/5000 series) are completely sealed. On balance I think this is probably a good thing because, by protecting the pots from outside chemicals, they seem to have a long and trouble free lifetime.

Has anyone figured out what to do when the pots finally become noisy? I would love to squirt a bit of tuner cleaner or equivalent onto the wipers to improve the noise but I can't figure out a way to get it into the pots. Then once it does its job how do you get the excess out?

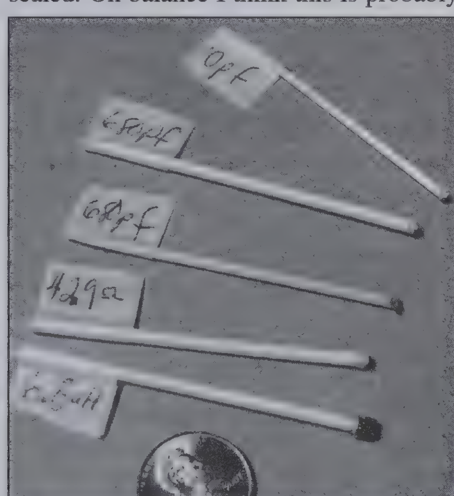


Figure 10—Homebrew SMT parts-on-a-stick, glued in place with 5 minute epoxy. (WA8MCQ photo.)

A reply from Peter Gottlieb—

I have a tiny drill bit in a finger chuck [*also known as a pin vise—WA8MCQ*]. It

Figure 11—Any type of SMT part can be used. Left to right, 6.8 µH inductor on a swab, 10 and 680 pF on toothpicks, 42.9 ohms and 680 pF on swabs. (WA8MCQ photo.)

is the size of a small PCB component lead hole. It is carbide so it will go through metal easily. I drill a little hole (or two if I can get to two sides) and put the cleaner tube against one hole and spray. Then I operate the control a number of times, and spray again with a tissue to soak up what comes out. If you know where to drill and are careful to keep the removed material from going inside, this works very well. Years later the pots are still working beautifully.

From Dennis—

Some of the Tek pots are very high end. They come in a square form factor and they have 4 tiny screws (one in each corner) that can be removed to take them apart. But the pots I am wondering about are the more common, less expensive round ones. At the moment I am looking at a pretty conventional looking Clarostat pot with a round metal case about 5/8" (15mm) diameter. It happens to be a dual pot but that isn't important in this case. Both are noisy.

I thought of drilling a hole into the pots but I decided the contamination from metal particles could be a worse cure than the disease.

Where exactly do you drill the hole in yours? I have lots of tiny carbide bits from the PC board industry. They can be bought surplus on eBay when they get too dull to be used to drill PC board material, but they are still pretty sharp. I even have some "wire" drills that go down to just fractions of a millimeter.

I used to do something like this at my previous job where we were trying to find out what kind of stuff was getting stuck inside our hermetically sealed integrated circuits. But in this case, using a milling machine and a tiny end mill bit I was able to drill down within a few thousands of penetrating the lid of the package. At that point I could press very gently with a needle and poke the remaining .001" thick disc into the integrated circuit from one edge using the opposite side as a kind of hinge. It was delicate but it worked most of the time. It was all done under a microscope.

From Peter—

The square ones were called "Modpots" and that trademark was A-B's. With different shafts and pot elements and different length screws you could make up just about anything.

Make sure to use the finger chuck. As you drill, you will see two spirals of metal or plastic come from the bit; nothing seems to go inside. Find a pot of each type you don't need, to break open and examine. Make absolutely sure not to drill through the resistive element. If you do that, the pot is trash. Also, be very gentle with the drill to make sure not to poke through and damage the wiper assembly. I have had great success, but the alternative was having to replace the pot anyway so there was nothing to lose.

From Dennis—

Follow-up on the noisy pots: It was getting late and, out of desperation, I removed the dual pot from the PG502 Pulse Generator that was noisy and I dunked it whole into Kester Flux Cleaner. After about 10 minutes I removed it and shook it off.

I didn't think there was any chance that it was going to get inside the pots where it could do some good. When I reassembled the PG502 the pots were working perfectly, no noise at all! Maybe it was just dumb luck. I checked the pots one more time to see if there was any way for the liquid to get into them and I can't see how it did, but the noise is gone.

WA8MCQ notes—You should be able to find pin vises at hobby stores. They are also carried by McMaster-Carr (http://www.mcmaster.com) and MSC (http://www.mscdirect.com), which are two excellent industrial supply companies, as well as tool vendors such as Techni-Tool and MicroMark, and many other places.

20 dB Coupler

A 20 dB coupler is very handy to have in the shop. It's been over a decade since I had something about one in this column (April 1997), so it's time for another. This is from the web page of Jim Kortge, K8IQY (www.k8iqy.com), under the Test Equipment section. Be sure to check out the rest of the page as well. *—MCQ*

One of the slickest ways to look at higher powered signal sources with a spectrum analyzer or other sensitive detector, without running the risk of burning out the front end, is to employ a –20 dB coupler. This simple device is nothing more than a 10:1 broadband transformer that reduces the power input to the detector by a factor

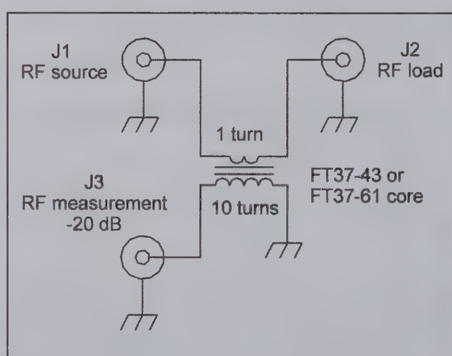


Figure 12—Diagram of the 20 dB coupler.

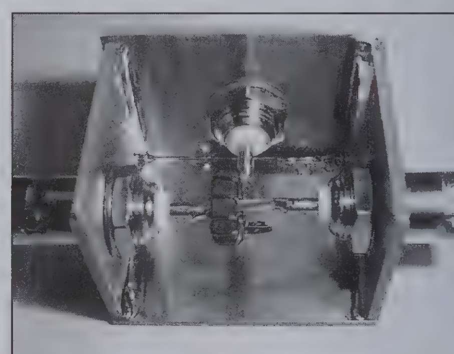


Figure 13—Typical construction of the coupler. (K8IQY photo.)

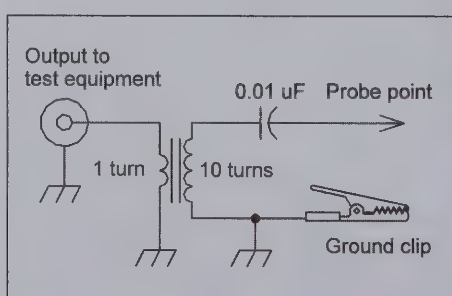


Figure 14—The 20 dB coupler used as a high impedance probe, with low loading of the circuit being tested.

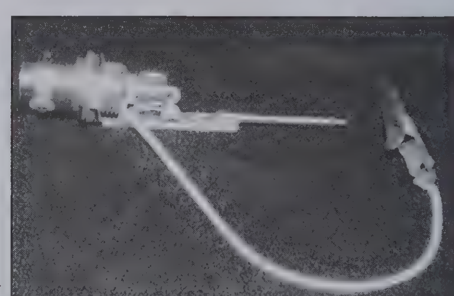


Figure 15—Construction of the 20 dB coupler high impedance probe. (K8IQY photo.)

Figure 16—The USM-323, military version of the HP 8640B signal generator.

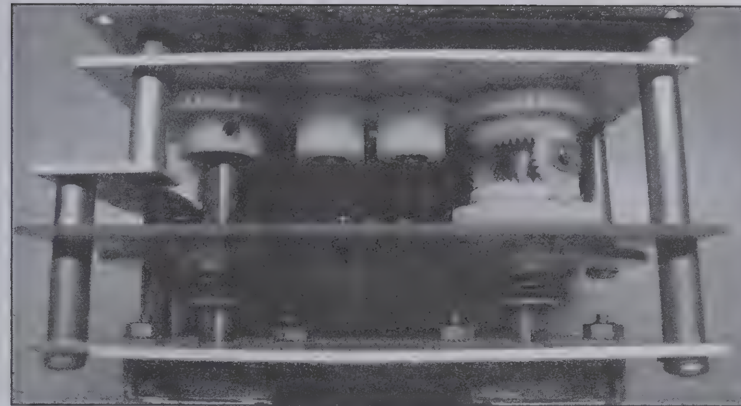


Figure 17—It is not unusual for some of the plastic gears in the 8640 to crack. The two larger ones on the right shaft have been repaired. (Erik Paret photo.)

of 100, or –20 dB. Using this device reduces a watt, 20 volt peak-peak signal down to a 10 milliwatt, 2 volt peak-peak signal while maintaining excellent fidelity.

Figure 12 shows the basic schematic of a –20 dB coupler. The RF source is connected to J1, the left port, a suitable load to the right port, J2, and the measurement instrument input to the bottom port, J3. The RF source might be the output stage of a QRP transmitter and the load, a 50 ohm dummy load. If the input impedance of the measurement instrument is 50 ohms, that input impedance is reflected back to the 1 turn transformer primary and looks like 0.5 ohms in series with the RF load.

Shown in Figure 13 is a more traditional implementation of the circuit. The case is constructed from PC board material, and three coaxial connectors are used. The toroid transformer has a single turn going through it, which is the primary, and 10 turns are wound around the core, forming the secondary. One end of the secondary leads feeds the third coaxial connector, J3, and the other lead is grounded to the case. This is the measurement port. Either of the other two ports can be used for the RF source or RF load.

A thin brass cover, not shown, closes out the case on the finished coupler.

Figure 14 shows an implementation of the coupler configured as a high impedance probe. The 50 ohm input impedance of the measurement instrument is in series with the 1-turn primary, and is reflected to the 10 turn secondary as 5000 ohms. This allows the low impedance instrument to be used to measure circuit performance without unduly loading that circuit and changing its performance.

Three stacked FT25-43 cores are used, wound with 10 turns of #28 wire, and slipped over the center pin of the coax connector. A piece of wire from the center pin to ground completes the primary circuit. One of the secondary leads is grounded, and the other connects to the probe point through a small 0.01 μF capacitor. A small piece of PC board material comprises the substrate upon which the parts are mounted. Figure 15 shows the details.

—DE K8IQY

Fixing Cracked HP 8640B Gears

The HP 8640B signal generator has been around for quite a few years now, and is a very handy thing to have for homebrewing. As time goes on it has come down in price quite a bit on the surplus market, and you could probably pick one up for just a few hundred dollars. Built before synthesized generators came into vogue, it starts out with a mechanically tuned cavity oscillator covering roughly 256 to 512 MHz. Various sets of dividers and filters are switched in to give 10 ranges covering 0.5 to 512 MHz. (It can also go up to 1024 MHz if an external frequency doubler is used.) A frequency counter monitors the output.

I have the USM-323 myself (Figure 16), which is the heavier military version permanently mounted in a large yellow transportation case. Also known as the HP 8640B Opt 323, it has a black front panel and lacks a couple of features of the commercial version (such as the frequency lock circuitry), but is essentially the same. The regular 8640B has a gray front panel and knobs, less of a military appearance, and does not have the carrying case. (You can find lots of them on eBay.)

One reason these generators are prized is the low phase noise of the output. They also have a well calibrated output level that goes from + 19 dBm all the way down to –145 dBm, making them good for doing receiver sensitivity tests.

There are some plastic gears in the band switch area (Figure 17) and they can crack as they age and the material shrinks. There do not appear to be any readily available replacements, so you have to choose between scrounging replacements from a scrap unit or repairing the gears. There was quite a bit of discussion of possible replacements for the gears on the HP/Agilent test equipment discussion group on yahoo.com some time ago, but nothing ever came of it. (See Reference 1.)

Repair usually involves pushing out the brass insert, reaming out the hole a bit, and then patching it all up with epoxy. Last year Erik Paret in Belgium posted a more robust method to the group which involves wire reinforcement.

The following is adapted from Erik's post on 16 August 2007, subject line "HP 8640B gears'—

I am happy to communicate that I found a way to restore the broken gears in the 8640B. As another member of this group suggested I used 2 part epoxy but with a modified procedure which should make them last forever, I hope.

1. Carefully push out the center brass insert. (Remove set screws first if necessary.)

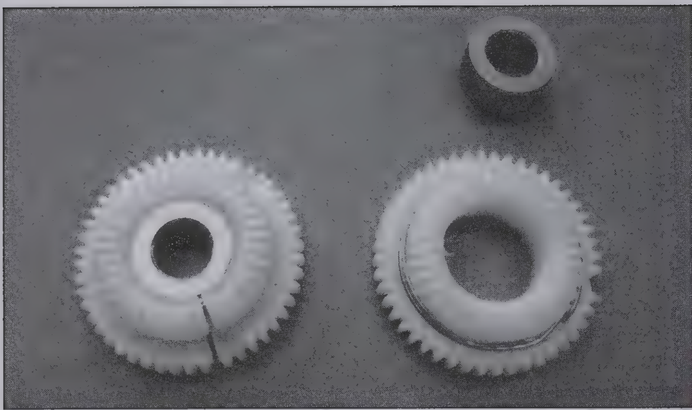


Figure 18—Two split gears, one with two turns of wire wrapped around it. (Erik Paret photo.)

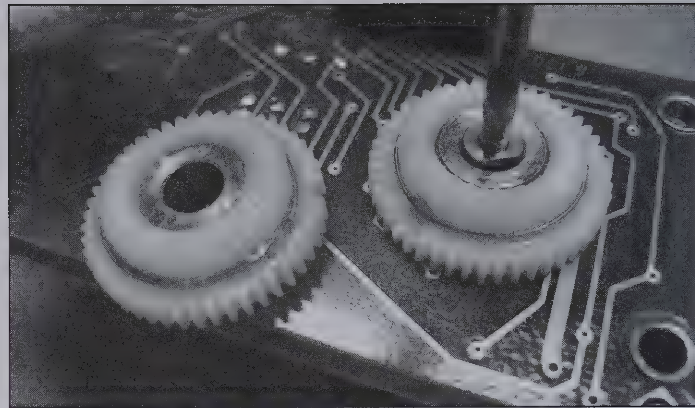


Figure 20—Two repaired gears. One has a missing tooth but is said to still work well. (Erik Paret photo.)

2. Gently squeeze the split gear together if necessary, closing up the crack. Using a small round file, carefully enlarge the hole so that the brass insert can be pressed back into place later.
3. Make two small holes in the side of the gear to allow wire to pass through.
4. Wrap the smaller part of the gear with wire (copper should do); the wire goes around about two times and the ends go through the holes. Cut the ends of the wire flush with the back side of the gear after tightening it a little bit.
5. Do not forget to put the set screws back into place, taking care not to damage the wire. You can push it back so that it only partially covers the screw holes; this part is a bit tricky.
6. Glue the whole thing together, including a bead of epoxy along the entire length of the wire. Take care not to use too much epoxy, otherwise the capillary effect will suck the glue into the teeth.
7. Allow to cure fully and reassemble. It works very well even with one tooth missing!

WA8MCQ comments—

I touched up and added to the text and changed the procedures a bit to make it clearer, at least to me, but I have not actually done the procedure myself. (I expect to have to do it sooner or later.) As a result there may be some errors and things may not be in the best sequence, but at least his basic ideas come across. And the most important part is his addition of wire for reinforcement.

Figure 18 shows two cracked gears. The one on the right has the reinforcing wire wound around it. Figure 19 shows the holes drilled for the ends of the wire; location is not critical and they need not be anywhere near the crack. Note that they are substantially larger than the wire diameter; it need not be a tight fit since everything is glued in place later.

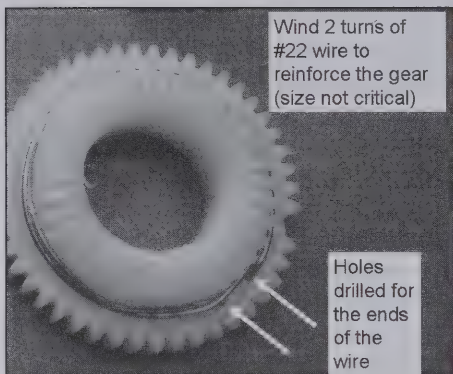


Figure 19—Wiring the gear. (Modified Erik Paret photo.)

The finished product can be seen in figure 20. Not too clear in the black and white photo but obvious in the original color shot, epoxy was applied along the entire length of the wire. It also appears that the brass inserts were glued in place, something recommended in the 8640 section of the VE7CA web site. (See reference 2.)

After Erik posted this, someone asked what sort of epoxy was used, wondering if it was Araldite. (That name should be familiar to anyone who reads the GQRP Club journal *SPRAT*, although it does not appear to be marketed anywhere in the Americas.) Erik replied that what he used is sold under the name Bison in Belgium.

Someone in the US suggested that Devcon "2 Ton" epoxy would also work. That brand is widely available in the US, usually in a dual chamber syringe, and "2 Ton" appears prominently on the package. (Wal-Mart usually seems to have the best price.) At work we call it "real epoxy." Devcon also makes a 5 minute epoxy which we use a lot in undemanding applications, but the "2 Ton" type requires an overnight or longer cure and is stronger. In general, for this type of repair I'd stick with a longer curing epoxy, not one that sets up in a few minutes.

Someone else wondered how well Erik's glue adhered to plastics, since his experience with Araldite was that it did not. Erik replied, "It seems to adhere quite well on the nylon, but I think adding the wire will at least multiply the strength by 10; I would not count on glue alone. The wire and the glue form a collar, so even when the glue does not adhere to the nylon it will still hold." In a later post he said the wire he used was tinned copper, about 0.6 mm diameter, which is about the size of our 22 gauge.

References:

1. The discussion group is hp_agilent_equipment on http://groups.yahoo.com/ and it stays pretty well on topic although there are occasional off topic posts about other types of equipment. If more interested in Tektronix test equipment, particularly oscilloscopes, try the TekScopes group on Yahoo. Even if you don't have any of the test equipment you might still find both groups interesting. (You'll have to sign up for an account with Yahoo, which is free.)

2. Markus Hansen, VE7CA, has a section of his web page devoted to the HP8640. The URL is http://www.shel-

brook.com/~ve7ca. Click on any of the 8640 links in the "site updates" list or click on Testing at the top and then on HP8640

Update on Pozidriv Screwdrivers

I mentioned this type of screw and driver in the Spring 2007 issue. As I said, it looks a lot like Philips but they are not quite the same. A Philips screwdriver will fit into Pozidriv screw heads but it feels very sloppy and imprecise. There is also a possibility of damage to the Philips screw and/or the Pozidriv driver. My main interest in them is the older HP test equipment I have at home. Their products of a certain vintage use this type of screw. I've always used Philips drivers on them but it just never felt right (because it wasn't).

I had given up on trying to find the drivers locally and finally bit the bullet and placed an order with McMaster-Carr, an excellent industrial supply house. (Their web site is www.mcmaster.com and they also have a very thick paper catalog.) ' I bought drivers for #1, #2 and #3, which are the same size as Philips screwdrivers, as well as several #2 power drive bits. (Those are the hexagonal drive bits that fit into electric drills and are about 2" long.)

When I finally put the proper driver into a Pozidriv screw for the first time in my life it was really dramatic. I ended up playing around for several minutes, alternating between Philips and Pozidriv drivers, savoring the experience. I even had my wife try it; she agreed that it made a huge difference having the proper driver.

Figure 21 shows the tips of both types of screwdrivers; both are #2 and the Pozidriv is on the right. It's not too obvious in the photo, but the 4 ribs on the Pozidriv are straight, not tapered like the Philips. Measuring from the end of the tips to about 0.250" away, the ribs on the Pozidriv are approximately 0.040" thick along the entire length. On this particular Philips they start at under 0.030" thick and end up at about 0.055". These tapers, or lack thereof, match those of the respective screws.

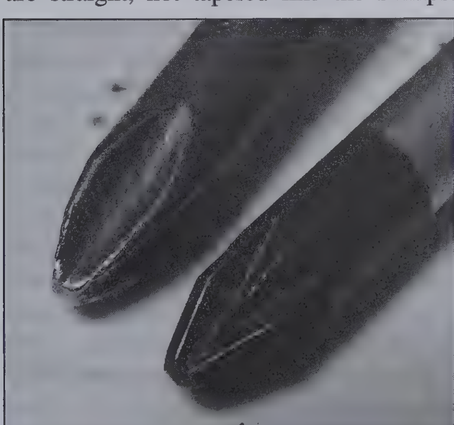


Figure 21—Philips screwdriver (left) vs. Pozidriv (right).

If you have any HP test equipment or anything else that uses Pozidriv screws, I'd highly recommend picking up one of the drivers. (#2 is probably the most commonly used size.) It's definitely worthwhile. There are many times in life where you don't want to buy something, finally do, and then wonder why you didn't do it years ago. This is one of those.

Here are some web sites where you can find more info on the Pozidriv:

http://en.wikipedia.org/wiki/Pozidriv

http://en.wikipedia.org/wiki/Screw

http://www.sizes.com/tools/screw_drive.htm

http://www.hafele.com/us/services/haefele-library/4300.htm

—DE WA8MCQ

Accuracy of the Heath QM-1 Q Meter

After I read on an e-mail reflector that Carey Fuller, KXØR, had picked up an old Q meter at a hamfest we ended up swapping quite a few e-mails about the subject. He indicated that he had some concerns about the accuracy of the Heath QM-1 that he bought, getting conflicting and inconsistent results. He had no way of aligning the unit according to the manual since it did not come with the "reference" inductor originally supplied with the kit. (The manual did not give any description of it, so one could not be duplicated.) Using the published Amidon/Micrometals Q charts for reference, he made and tested a number of coils. The following is adapted from a number of e-mails reporting his progress. (The Winter 2008 issue contained some QM-1 photos that he supplied.) *—MCQ*

The "calibration" of the QM-1 does not hold over frequency, based on the Q curve data.

I've studied the QM-1's schematic, principles of operation, and physical layout (see Figures 22 and 23), and I cannot explain why the calibration changes with frequency. Clearly either the Q-signal detector circuit or the crystal diode circuit used to set the drive level have errors as the frequency changes. I can't see why. The injection to the inductor being tested comes from a capacitive divider, which should produce a constant ratio as frequency varies. Tests with a scope suggest that the RF drive is being measured well enough as frequency varies. The drive is a pretty good sine wave. It comes from a relatively low impedance cathode follower before going to the capacitive divider. The large capacitor in it is a special stacked mica unit, and it measures within a few pF of the 5000 pF listed in the manual. The upper capacitor in the divider is a variable ceramic capacitor of 7-35 pF, and this internal adjustment is used to calibrate the injection level.

It's a simple circuit, and while I don't expect great accuracy from something so basic, it's not clear why there is such a large error over the ranges. Changing frequency in this unit only affects the oscillator LC circuits; the detector and VTVM remain unchanged on all ranges.

From a later e-mail—

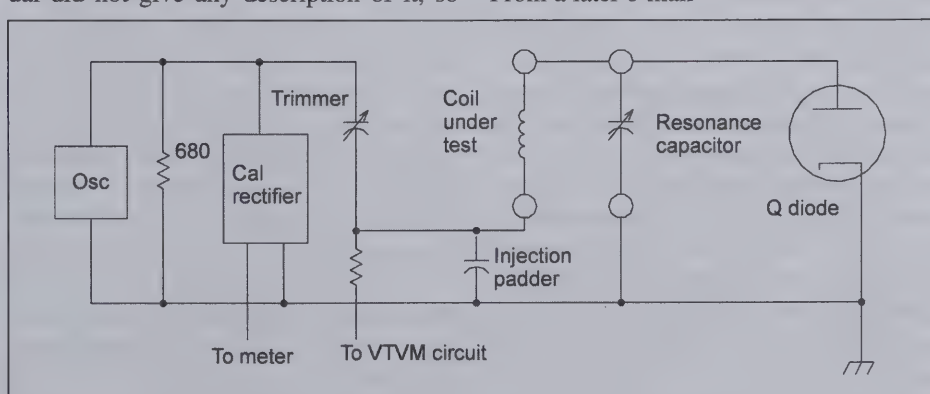


Figure 22—Block diagram of the QM-1 (redrawn from the manual).

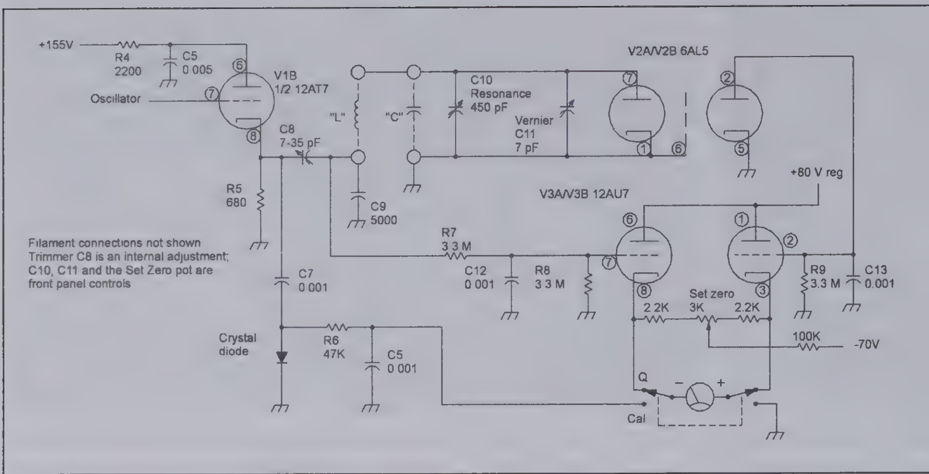


Figure 23—Partial schematic of the QM-1 (redrawn from the manual).

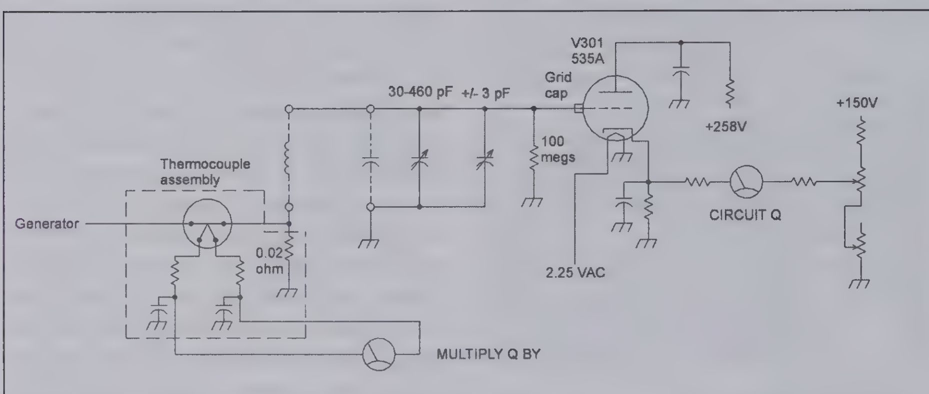


Figure 24—Simplified partial schematic of the Boonton 260A Q meter. (The portion on the right side of the Circuit Q meter is much more complex than indicated.) The plate voltage of V301 is correctly shown as +258V.

Without getting into more detail now, the QM-1 is a very inaccurate device. I found another way to measure Q based on bandwidth; this is far from trivial, and it becomes difficult when the Q exceeds 300. I was able to get pretty good agreement between my measurements and the Micrometals Q curves—mostly within 20 or 30 percent. The QM-1's accuracy is much worse; it doesn't match its meter markings even at one frequency for one inductor; this can be verified by adding resistors to reduce the Q. It also doesn't hold over frequency, or over any one range. The readings depend on characteristics of the vacuum diode detector, including its filament voltage, and there are surely other problems. The QM-1 is useful for making comparisons and rough measurements.

From a subsequent e-mail—

Here's what I have learned about the QM-1 and why it's so inaccurate:

The signal source in the QM-1 is a cathode follower driving a capacitive divider. The capacitor at the bottom of the divider is a special 5000 pF mica unit. The inductor being tested is driven right from the junction of the divider. The inductor under test is in series with a variable tuning capacitor with a maximum capacitance of about 500 pF.

A simplified example helps explain the problem:

Assume we drive the series resonant circuit with 10 MHz, and we have an inductance of 0.5 µH. The reactance is about +j32 ohms. The variable capacitor must be set to about 500 pF to achieve resonance, and its reactance is –j32 ohms. Assuming Q is 100, the effective series resistance is 0.32 ohms.

This series circuit is being driven from a capacitive divider with 5000 pF on the bottom. The reactance of 5000 pF at 10 MHz is about –j3.2 ohms. So we have a reactive source of 3.2 ohms trying to drive a resistive load of 0.32 ohms. Clearly, the source voltage will vary as we tune through resonance. The higher the Q of the circuit, the worse the loading effect is, because Rs is going down.

The QM-1 sets the source voltage at the top of the capacitive divider; a germanium diode meter is used. While there is only a small variation at this point as we tune through resonance, the voltage at the actual drive point does vary greatly, which I confirmed using a scope. It is due to the loading of the series resonant circuit being measured. For the measurement to be really useful, it should be done at the drive point for the circuit being measured. The voltage variation is strongly asymmetric on each side of resonance.

This example also explains why the QM-1 seems to read Q's lower near maximum variable capacitance and higher near minimum capacitance. If the variable capacitor in the series circuit is small, for example, 100 pF at 10 MHz, then its reactance is about –j159 ohms, the inductor is +j159, and for a Q of 100, the effective series resistance is 1.59 ohms. The lower capacitive divider capacitor is still 5000 pF, or –j3.2 ohms, so the loading from the series circuit is reduced as we reduce the variable capacitor.

In order to measure Q accurately, the source driving the series circuit must supply a nearly constant voltage. From the numbers in the example, it's clear that this source should have an impedance that's small in comparison with the load. Since the effective resistance for high Q coils may be on the order of 0.1 ohm, or lower, the source should be .01 ohm or lower; and there should be some kind of feedback or leveling applied to hold the source constant. I imagine that the better instruments are designed to provide constant drive, since that's the root of the measurement.

WA8MCQ notes—Figures 24 and 25 show partial circuits of the old Boonton/HP 260A and newer HP 4342A Q meters. In the 260A the drive level is measured at the injection point with a frequency insensitive thermocouple feeding a dedicated meter, with the level manually adjusted as needed by the user with a front panel control. The signal is injected into the inductor under test from a 0.02 ohm resistance; the older Boonton 160A Q

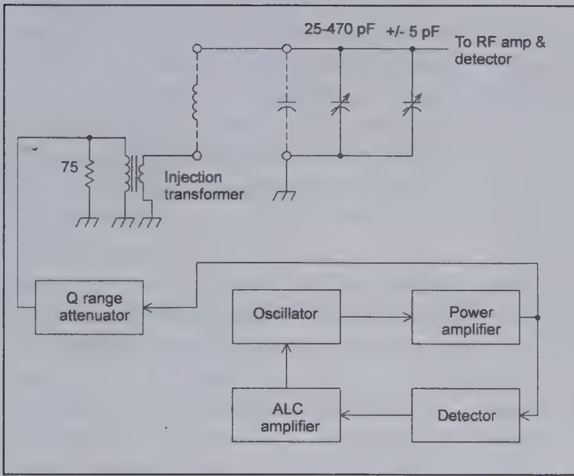


Figure 25—Partial block diagram of the HP 4342A.

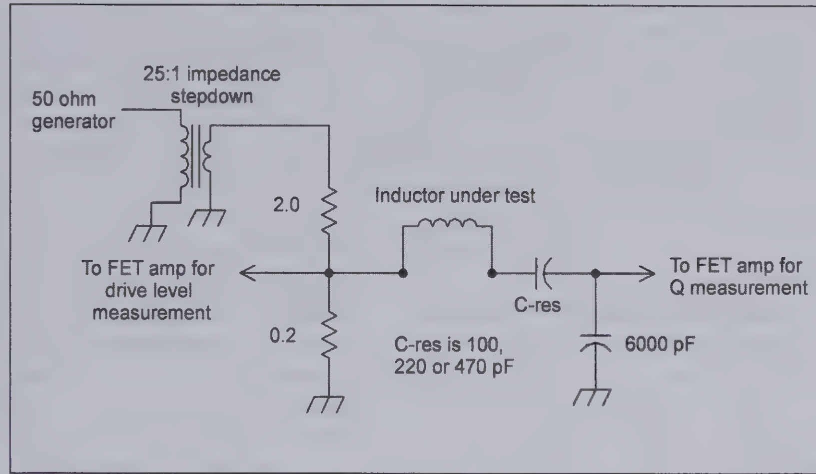


Figure 26—The KXØR setup for measuring Q.

meter used 0.04 ohms. In the 4342A the signal level is kept constant with an ALC feedback loop. The level is initially set with an internal adjustment when the unit is calibrated, and cannot be adjusted by the user from the outside. The signal is applied through a wideband transformer which has an output impedance of 1 milliohm. Manuals for both units can be found in various places on the Internet; details on request.

All 3 models have two variable capacitors to resonate the inductor under test, giving coarse and fine adjustments; the values are similar on all three. When doing a measurement the smaller cap is initially set at midpoint, where there is a "0" on the dial. If that cap is tuned for a fine adjustment, the dial indicates the amount of capacitance that is added to or subtracted from the dial of the larger cap.

All three units have four binding posts in the test area, as shown in the figures, where dashed inductors and capacitors are shown connected. The dashed capacitor is not normally used. An inductor is connected as shown and the two variable caps are tuned to achieve resonance, indicated by a peak reading on the Q voltmeter. If the capacitance of the two caps is insufficient to resonate the inductor at the desired frequency, their range can be extended by adding a capacitor of known value to the other set of binding posts. Another situation in which a cap is connected there is when measuring an unknown capacitance, which requires an inductor of known value to be connected as well.

KXØR continues—

The method I used to measure Q independently of the QM-1 is shown in figure 26. The 0.2 ohm resistor consists of five 1.0 ohm carbon resistors in parallel. The output of a 50 ohm signal generator is fed into a transformer wound on a type 43 toroid with 5 pieces of #28 wire twisted together to form the "rope." They are connected to give a 25:1 impedance step-down ratio. (It isn't as broadband or as efficient as it should be. It works OK up through about 5 MHz, and falls apart above 10 MHz. I've not worked on improving it, but it's probably the weakest part of the measurement now.)

Resonating capacitor C-res is usually 100 pF, 220 pF, or 470 pF. The 6000 pF capacitance is made of several smaller units in parallel. The measurement of the Q voltage is taken from the top end of that, to reduce loading on the series circuit.

Q is to be measured from bandwidth at the half power points. Initially I tried using a x10 scope probe to measure the various voltages. This caused detuning effects, and I had serious trouble with signals from local commercial radio stations getting into the measurement. I then made small FET amplifiers for the scope to measure both the Q signal at the series-resonant circuit and the drive signal at the 0.2 ohm resistor. The little amplifiers cause only tiny loading effects and they are connected all the time. They also provide some useful gain. The scope is connected to a source-follower on each amp, so it works much better, and the RF interference is insignificant.

To measure Q, I set the signal generator so that the series circuit is at resonance. I look for peak output across the 6000 pF cap (measured via FET amp). This must be done very carefully for exact resonance. I record the frequency, then I measure the drive level across the 0.2 ohm drive source resistor, via the other FET amp, using the scope. I adjust the signal generator for a convenient level and write down the value. Then I go back and measure the peaked-out signal from the Q circuit and record that. Next, I multiply it by 0.707 to determine the half power level.

Here's where it gets interesting:

The generator's frequency now must be set on each side of resonance so that the signal level from the Q circuit is 0.707 times what I measured at resonance. These are the half-power points. If I retune the generator to the half-power level, and then check the drive level at the 0.2 ohm resistor, I find that loading effects have changed the drive considerably. For the half-power points to be meaningful, the drive level must be held constant! Therefore I play a game of iteration to adjust the drive level and frequency, back and forth, so that I can measure the frequency of the half-power points with the same drive level that was measured at resonance. This is tricky, but with practice the adjustments converge, and accuracy can be achieved. I divide the frequency of resonance by the bandwidth between the half power points to get Q.

The measurements are very repeatable if done carefully. The higher the Q, the more the drive and frequency interact. The results do agree pretty well with the Micrometals Q curves so I have some confidence in the method, but it's tedious.

It will be interesting to measure the

sample coils you will be measuring and sending, and compare my results to yours. It all boils down to very low impedances and resistances—no wonder it's so difficult. It's clear that the QM-1 cannot be fixed or corrected easily. I have learned a few things by exploring this question.

—DE KXØR

Transistors for Homebrew Radios

Harold Smith, KE6TI, submitted the following useful information:

Some of the transistor types used in homebrew radios over the years have become obsolete or scarce, but there are still plenty of available parts to choose from. (Figures 27 through 39 show pinouts of many useful transistors.)

For the small-signal NPN, such as are used in oscillators, buffers and low power amplifiers, the 2222 family is still a good choice. It comes in the original metal TO-18 (2N2222 and 2N2222A, with the A versions having slightly higher gain at a given frequency), the plastic TO-92 (PN or MPS2222 and 2222A), and a number of surface mount packages. The 2N4401, PN3643 and probably others are very similar, coming from the same die source.

Another family of transistors for the same applications is the 2N3904 and 2N4124. They differ in their voltage ratings but come from the same die source, so are basically the same. These and the 2222 family are easily good from audio to the low VHF region. Both families are very inexpensive in plastic packages.

There are PNP complements to both of the above families. For the 2222s the complements are the 2907 family (and 2N4403 and PN3638), and for the 3904/4124 the complements are 3906/4126.

For higher frequencies, or where higher per-stage gain is needed, the TO72 2N5179 and the TO92 PN5179, 2N5770, MPS-5179, MPS-H10 or MPS-H17 are good choices. The TO-72 package is getting rare, but the TO-92 parts are still widely available, and almost as inexpensive as the first two groups. These are all NPN. PNP complements to these parts are very rare. About the only inexpensive TO92 VHF PNP left is the MPSH81, which is not a true complement to any of the above parts.

For power stages at the one or two watt level there are still a lot of choices. TO92 packages are dissipation limited, so it is probably a good idea to look to larger packages. The 2222 family is available in the TO39 metal can as the 2N2218(A) and 2N2219(A), and in a 1-watt-rated stretch TO92 (TO226) as the TN2219A, which is much cheaper than the metal cans. The TO39s are getting expensive, as are any metal-can transistors. The 2N5859 and the 2N5189 are history, but the similar 2N3725A is still manufactured, and is also available in the stretch TO92 as the MPSW3725. Other TO39s include the popular 2N3053 and the older RF power types such as 2N3866, 2N4427 and 2N5109. These are still sometimes available, but currently are manufactured mostly by replacement semiconductor houses. There are also stretch TO92 versions of the 2N3053 called the MPSW05 and MPSW06, which differ in voltage ratings. (The MPSA05/06 are the 2N3053 die in a standard TO92.)

Perhaps better than the TO39 metal can parts are the plastic power transistors in TO126 and TO220 packages. These are usually easier to find, and often easier to build with. In the TO126 are the KSD882, MPS180-182, BD139, 2SC1846 and 2SC2314. The last is specified as an RF power transistor. It is somewhat harder to find than the others, since it is not carried by the big distributors, though it is available through dealers that sell to the repair trade.

The TO220 transistors include a number specified as RF power amps, such as the 2SC1678, 2SC2075, 2SC2078 and 2SC2166, but these are mostly discontinued and getting hard to find. The 2SC5739 is easy to get, cheap, and about as good at RF, and in addition needs no insulator between its tab and heatsink. Unfortunately most of the more common TO220 transistors, such as the TIP series, do not have the frequency response to be good RF amps, but are perfectly suitable as audio amplifiers.

Other small signal bipolar transistors that might prove useful are the MPSA14, which is a Darlington with a beta of 10000 or more, and the KSC1187, which may be the last TO92-packaged forward AGC transistor in volume production.

N-channel JFETs are still plentiful, but primarily in TO92 and surface mount packages. The metal U310 and 2N4416 are still available but expensive. Plastic versions of each are much more available and affordable. The J308-310 are the plastic equivalents of the U308-310, and are, for most RF uses, the best choice. They are based on larger die than the 4416 derivatives, though, so have somewhat larger capacitances and somewhat larger Idss.

The plastic packaged JFETs from the 4416 family include the 2N5484-86 and the 2N5949-53. The former parts are more commonly encountered, especially on the surplus market, but the latter are more tightly specified, which can be an advantage in some designs. There is not a general cost difference between the two groups.

The well known MPF102 is also still available, but it no longer offers the cost advantage it used to, and it is a very loosely specified part, basically a way for manufacturers to sell the parts that would not fit anywhere else. The parts in the previous two paragraphs are the better choice.

Low power N-Channel MOSFETs in TO92 packages include the 2N7000, the VN10, and the VN2222, all of which are similar. The 2N7000 is often the least expensive, and carries the highest ratings.

In the higher power TO220 MOSFETs that can be used as RF power amplifiers, only the IRF510 is still around, and it is nearing obsolescence. The VN66 family is history. Mitsubishi has a new family of RF power MOSFETS, intended to replace the discontinued 2SC2166 and 2SC1969 type bipolars in CB output stages. They are, unfortunately, hard to find without dealing with large minimum orders. The part numbers are RD06HHF1 and RD16HHF1.

—DE KE6TI

Transistor Types Represented by Each Figure

Figure 27: 2N3904, 2N3906, 2N4124, 2N4126, 2N4401, 2N4403, 2N5086, 2N5087, 2N5210, 2N5771, 2N5772, KSC1187, MPS2222(A), MPS2907(A), MPS5179 (NOT PN5179), MPS-A05, MPS-A06, MPS-A13, MPS-A14, MPS-A20, MPS-A55, MPS-A56, MPS-W01, MPS-W06, MPSW3725, PN918, PN2222(A), PN2369(A), PN2907(A), PN3646, PN3563, TN2222(A), TN2219(A), TN2905(A), TN2907(A).

Figure 28: MPS-H10, MPS-H17, MPS-H81, PN5179 (NOT MPS5179).

Figure 29—TO-92 (European transistors): BC546, BC547, BC548, BC556, BC557, BC558.

Figure 30—TO-92 (most Japanese transistors, some American): 2N3390, 2N3391, 2N3663, 2N3702, 2SA1015,

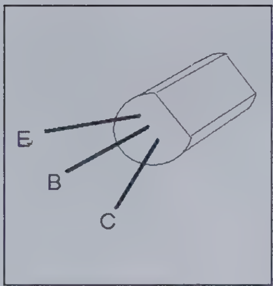


Figure 27—TO-92 (most, but not all, American TO-92, including stretch TO92).

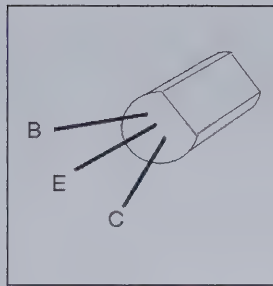


Figure 28—TO-92 (VHF transistors).

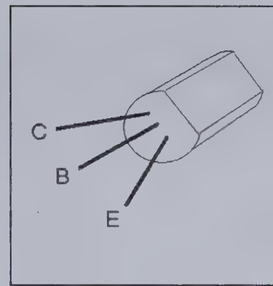


Figure 29—TO-92 (European transistors).

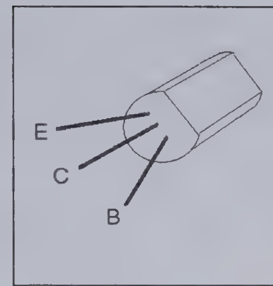


Figure 30—TO-92 (most Japanese transistors, some American).

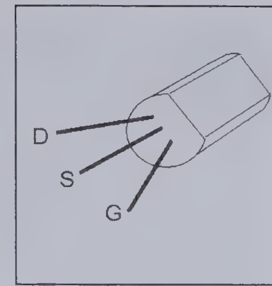


Figure 31—TO-92 JFET, version 1.

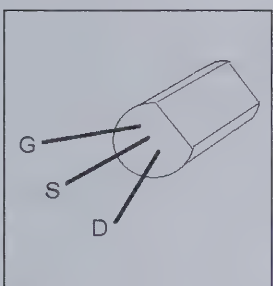


Figure 32—TO-92 JFET, version 2.

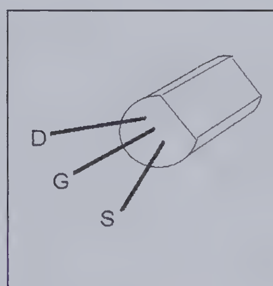


Figure 33—TO-92 JFET, version 3: 2N3819, BF244.

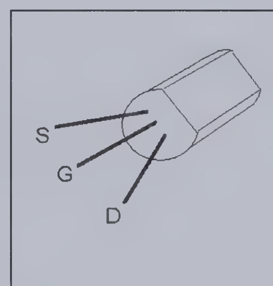


Figure 34—TO-92 MOSFET.

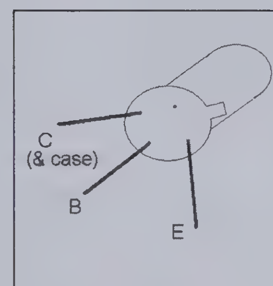


Figure 35—TO5, TO18, TO39, TO72*.

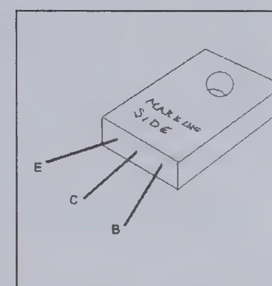


Figure 36—TO126.

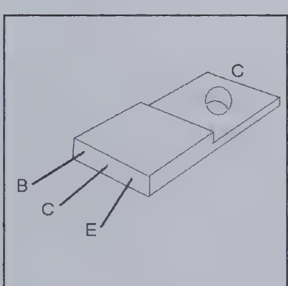


Figure 37—TO220.

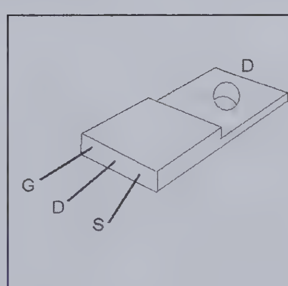


Figure 38—TO220 MOSFET.

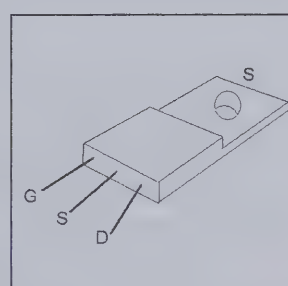


Figure 39—TO220 RF Power MOSFET.

2SC945, 2SC1815.

Figure 31: 2N5457, 2N5458, 2N5459, 2N5460, 2N5484, 2N5485, 2N5486, J210, J211, J212, J304, J308, J309, J310, MPF102, PN4391, PN4392, PN4393.

Figure 32: 2N5245, 2N5246, 2N5247, 2N5949, 2N5950, 2N5951, 2N5952, 2N5953.

Figure 33: 2N3819, BF244.

Figure 34: 2N7000, VN10, VN2222.

Figure 35: 2N1711, 2N2102, 2N2219(A), 2N2222(A), 2N2270, 2N2369(A), 2N2905(A), 2N2907(A), 2N3053, 2N3553, 2N3725(A), 2N3866, 2N4427, 2N5109, 2N5188, 2N5189, 2N5320, 2N5322, 2N5859, most transistors in these packages. Collector is usually connected to metal case. Some RF power devices were made with the emitter connected to the can, sometimes with emitter and collector pins swapped.

* The TO72 4-pin metal case (2N5179, 2N918) usually has the same pinout, but the case is connected to the fourth lead.

Figure 36: 2SC1846, 2SC2314, BD139, KSD882, MJE170, MJE172, MJE180, MJE182, most transistors in this package. There may be a metal pad on the bottom, connected to the center lead.

Figure 37: 2SC1678, 2SC1969, 2SC2075, 2SC2078, 2SC2312, 2SC5739, MJE2955T, MJE3055T, MRF475, MRF476, TIP-series, most transistors in this package. Tab may be insulated or connected to center pin. Some RF power devices were made with the collector and emitter swapped, to allow grounding the tab.

Figure 38: 2SK2162, IRF510, IRF530, MTP2955, MTP3055, Most low frequency power MOSFETs in this package. Tab may be insulated or connected to center pin.

Figure 39: RD06HHF1, RD06HVF1, RD16HHF1.

The Fine Print

Have any ideas, circuits or stories you want to share? Send 'em in. They can be via e-mail, floppy, CD, even handwritten, and you don't have to worry if you're not a professional writer. We take care of any editorial duties required. See something good online that's worth sharing, either on your own web page or someone else's? Let me know the URL and I'll take it from there. (Permission is usually easy to get.) And although some people provide their own computer generated graphics, you can just send in a hand drawn schematic if you like and I'll be happy to draw it up myself. Whatever it is, if it's something that our readers would find interesting, just get it to Severn one way or another; operators are standing by!

RG-6 for Transmitting Applications

Owen Duffy—VK1OD owen@vk1od.net

Editor's Note: This article was derived from material made available on Owen Duffy's website: http://www.vk1od.net/RG6/. Owen has kindly allowed us to reprint his material here.

Introduction

RG-6/U (RG6, RG-6, RG6/U) type coaxial transmission line is widely used for receiving applications. This article explores use of RG-6/U coaxial transmission line for transmitting applications. Although a 75 ohm cable, RG-6/U is of good quality and readily available, because of its use in cable TV systems, at attractive prices.

Costs

Table 1 shows the approximate cost (A$) of materials from my trade supplier, other suppliers may have different prices. Price comparisons are difficult when budget value cables are not all available from the same supplier. Figure 1 shows the relative cost of the cables used in this article. The prices for most are from a trade supplier, retail prices are typically 30% higher. The supplier does not sell RG8/X type so no price is given, but it seems to sell in the US for around US$1/m (about A$1.10/m, though it would probably sell for more than A$2/m in Australia). The LMR240 type price is from a retailer. The prices shown in Figure 1 are for budget versions of the cables, but cables that are of adequate quality for the task.

Item	Cost (A$)
RG-6/U dual shield	$37.00/100m
Compression tool	$48.00
Cable trim tool	$13.00
BNC connectors	$2.15
BNC(f)-UNF(m) adapter	$2.70

Table 1—Cost of RG-6/U and related items (in A$).

Application in 50Ω systems

Some applications may use 50Ω antennas and may require the transmitter be presented with a 50Ω load. This section canvasses some techniques for using RG-6/U (Zo=75Ω) in such a system.

One approach to matching RG-6/U to a 50Ω system would be to use a broadband transformer. Such a device can be constructed using a ferrite or powdered iron core to effect a transformation from 75Ω to 50Ω. The turns ratio would be (75/50)^0.5 or 1.23.

A second approach would be to use a quarter wave transmission line of the proper impedance to make a quarter wave transformer. A quarter wave transformer is a narrow band impedance transformer, and depends on a quarter wave transmission line of Zo=(50*57)^0.5 or 61Ω between the 50Ω load and 75Ω line (and vice-versa). Unfortunately, 61Ω line is not readily available, and so needs to be constructed.

The "twelfth wave" transformer is a narrow band transformer. It is a series cascade of a section each of 75Ω line and 50Ω line of length nominally 30° each between the 50Ω load and 75Ω line (and vice-versa). Figure 2 shows the length of the nominal twelfth wave sections for different impedance ratios. For example, the case of 75/50 is 29.3°.

Loss

Figure 3 shows the loss of common low cost coax cables. RG-6/U happens to be the lowest cost cable and it has loss comparable with the most expensive cable in the group, being RG213.

Fig. 3 employs a loss model that is based on the following assumptions:

- R is proportional to square root of frequency
- L is constant
- G is proportional to frequency
- C is constant

These are reasonable assumptions for most practical transmission lines with homogenous conductors down to about 100 kHz. Transmission lines that use conductors that are not homogenous, eg copper clad steel, silver plated copper clad steel (CCS), will not conform to the loss model at low frequencies where the outer layer of the conductor is less than a few skin depths in thickness. For more infor-

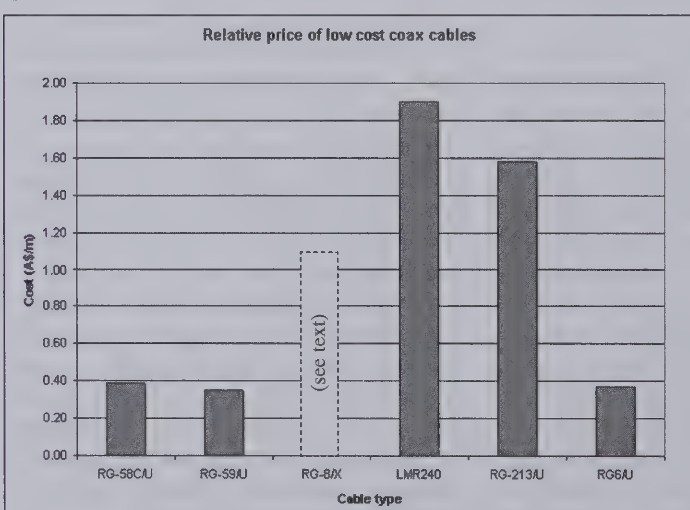


Figure 1—Cost comparisons (in A$) for various coaxial cable types.

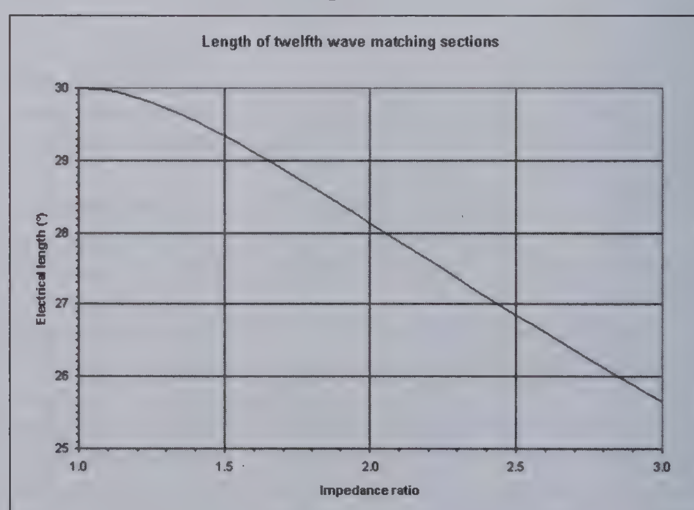


Figure 2—Electrical length of twelfth wave sections (in degrees).

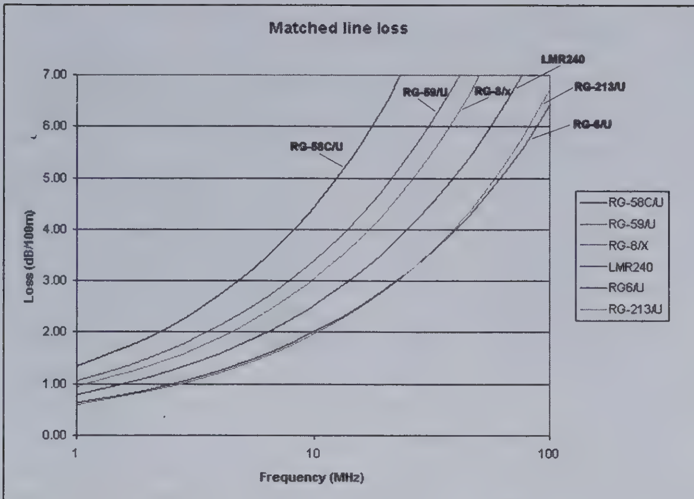


Figure 3—Matched line loss of coaxial cable types.

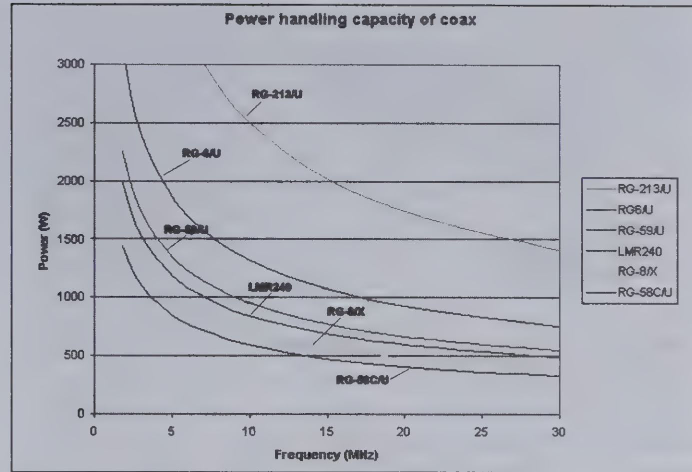


Figure 4. Maximum power handling capability for various coaxial cable types

mation on the loss model, see the Transmission Line Loss Calculator, available on my website, http://www.vk1od.net/tl/tllc.php. Some types of RG-6/U use a CCS centre conductor and will have higher loss at low frequencies than shown in Fig. 3, depending on the thickness of the copper cladding which may vary from cable to cable.

Power Handling

Coax has two limits to its ability to handle power: voltage breakdown, and thermal breakdown.

Voltage breakdown is nearly instantaneous, and so limits the peak power handling capability of the cable. The breakdown voltage of RG-6/U is typically around 2.7 kV, which would be reached at a power level of nearly 50 kW in a matched 75Ω system. For most applications, voltage breakdown is less limiting than overheating. Nevertheless, it is always a good idea to make sure that voltage breakdown is not a limiting factor for a particular application.

Thermal breakdown is generally caused by an inability to safely dissipate power due to I^2R cable loss. The maximum power is thus limited to that value which can be dissipated without raising the cable above its maximum operating temperature of typically about 80°C. Figure 4 shows the average power handling capability of common coax cables operating in still air at 40°C, with VSWR=1, and based on the loss assumptions stated above. Fi.g 4 is reverse engineered from a table in the ARRL *Antenna Handbook* using the loss model used for the Transmission Line Loss Calculator, and figures for RG-6/U and LMR240 estimated considering the dielectric type.

Operation of a cable at VSWR >1 reduces it power handling capability. The effect is that power handling is reduced due to increased voltage at voltage maxima and increased heat dissipation at current maxima.

On the assumption that most power that is lost is lost as I^2R loss in the R element of the RLGC model, average power handling capability is reduced by a factor equal to the VSWR. So for example, if the capability of RG-6/U at 7 MHz is 1580W with VSWR=1, it would need to be derated to 1580/2 or 790W if VSWR=2.

Because of thermal inertia, the cable temperature increases as a result of power averaged over time. A higher peak power may thus be allowed because the duty cycle (transmitter on/ off cycle) and modulation type reduce the average power for a given peak power.

For example, considering only the modulation type, the peak to average ratio for compressed SSB is about 15 dB, for a factor of about 30. Considering again the example of RG-6/U at 7 MHz, with maximum average power of 1580W if VSWR=1, RG-6/U would withstand 30*1580W or 47 kW PEP of SSB telephony from a thermal limit perspective. But for A1 type Morse code with a peak to average ratio of about 2.2, the thermal limit would be 2.2*1580W or 3.5 kW. These calculations assume that the period of on/off duty is short compared to the thermal time constant of the cable. If so, duty cycle can also be considered in rating the cable for the specific application.

Connectors

Connectors for RG-6/U are usually specific to the type of cable construction. Connectors are readily available for F, RCA and BNC. BNC connectors are the most interesting for transmitting applications. F connectors have a significant disadvantage in that the connector shield connectivity is very depend on the tightness of the nut (like some other kinds of connectors, such as UHF connectors) and is less suited than the BNC connector where both the inner conductor and shield connectivity are independent of the mechanical retention mechanism.

Figure 5 shows a compression type BNC connector for RG-6/U before installation and the cable trim dimensions for the BNC connector. 16 mm of cable jacket should be inserted inside the un-compressed connector for proper termination, and it is worth marking the cable with tape to visually ensure full engagement.

Figure 6 shows the cable preparation detail and assembly for compression BNC connectors. The picture is over simplified, in that the plastic sleeve that is "compressed" actually slides into the connector body taper, pressing the coax outer conductor against the barbed tube that slides between the dielectric and the shield. The final step is the concertina of a section of the plastic sleeve into the jacket as shown.

Note that 6 mm of exposed braid and shield should be folded back over the out-

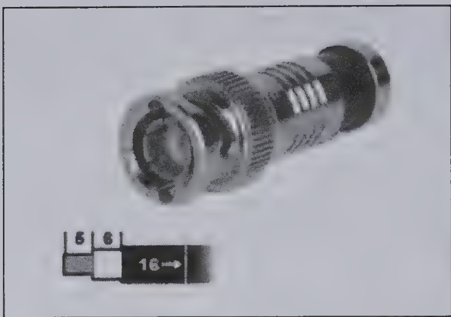


Figure 5—Compression-type BNC connector for RG-6/U.

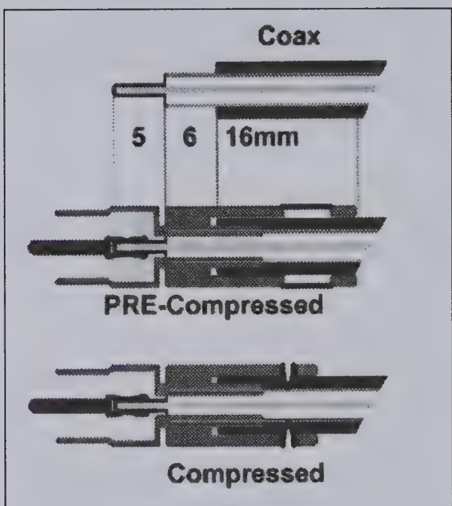


Figure 6—Cable preparation detail and assembly for compression BNC connectors.

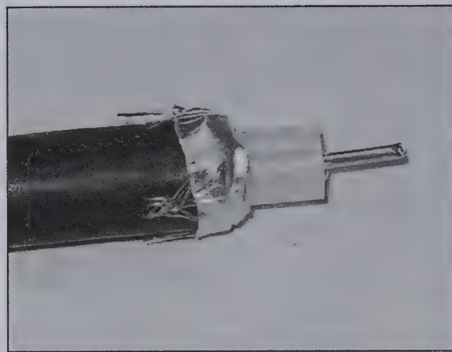


Figure 7—RG-6/U cable prepared for a BNC connector

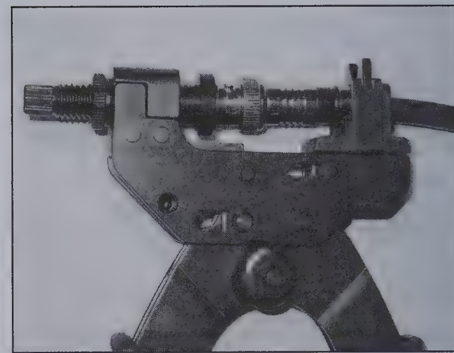


Figure 8—Compression tool for BNC connectors

side of the jacket. See Figure 7. With quad shield cables, the outer foil can be cut off and discarded, but the inner foil should be folded back as shown to facilitate correct engagement of the connector. If the inner foil is glued to the dielectric, leave it in place and just fold the outer layers back. Cable preparation is made easier using purpose designed tools that are quite inexpensive. Without rushing, and taking time to check the work, it is quite easy to terminate a cable in less than a minute. Figure 8 shows one type of tool that can be used for applying compression connectors. The BNC connector is shown prior to compression.

Connectors can be obtained with color coded compression sleeves and/or color coded identifying rings which install over the connector body. Most connectors of this type are designed to be waterproof when coupled to a BNC socket. Compression connectors are also available for RCA and F connector.

Versions of RG-6/U Available

RG-6/U is available in a wide range of forms: single, Double, and Quad shields; braided, and foil shield, and in combination; copper, and copper clad steel inner conductor; foamed polyethylene; and formed polyethylene dielectric. Because of the many forms of this cable available, make no assumptions about its velocity factor. Measure your cable's velocity factor for length-critical applications.

The ability to make a soldered connection to the shield is a distinct advantage for terminating cable other than on compression or crimp connectors. RG-6/U cable often uses a shield that is a combination of foil and braid. The foil may be aluminum, or more commonly aluminized plastic film. The braid may be made of copper wires, aluminum wires, or a combination of both. Copper wires used in the braid are often plated and have a silver color. Combination copper wires/aluminum wire braids are almost always plated copper. Copper wires are solderable, some combination copper wires/aluminum wires are solderable. If a solderable shield connection is important, a cable with copper braid or copper wires/aluminum braid should be selected, and a sample tested for solderability.

For most HF transmitting purposes, there is no real need for the quad shield types of RG-6/U. A dual shield cable will be cheaper and easier to terminate. Single shield cables are somewhat rare, but with adequate braid covering are fine for HF.

CCS centre conductors are often used for RG-6/U. If the copper cladding is not sufficiently thick, skin effect losses on the centre conductor will be higher than indicated in Fig. 3 at low HF frequencies. A cable with hard drawn copper centre conductor avoids this issue.

Be sure to visit the online home of QRP ARCI:
www.qrparci.org

Juma TRX2: QRP with a Finnish Influence

Pete Meier—WK8S
pmeier@mac.com

The Amateur Radio Community, in particular the QRP subset of that community, has always been blessed with talented individuals from diverse backgrounds and places all around the globe. Generally, we hams are a low keyed group who enjoy our hobby peacefully in the backdrop of our busy world. Such is true of a pair of Finnish hams, Matti Hohtola, OH7SV and Juha Niihikoski, OH2NLT, whom I discovered have quietly developed some very uniquely, designed radios. This article reviews their current project the JUMA TRX2, my experience building this kit and my first impressions in using it.

Introduction

Like the legendary Phoenix, the JUMA radio has risen from the ashes of an idea abandoned in the '90s, to mature into a novel transceiver concept a decade later. After four years in development Matti Hohtola and Juha Niihikoski are introducing their design to the Amateur Radio community as a high quality kit. The TRX2 is a modern, direct conversion HF transceiver with high dynamic range for SSB and CW. It uses the quadrature sampling technique for modulation and demodulation with a low noise phasing method. It employs a DDS controlled VFO for excellent frequency stability and signal purity. An internal microcontroller controls the various other functions of the transceiver. The TRX2 has a simple user interface with few buttons and knobs but clever engineering and programming bring some surprising features in a compact design.

JUMA Project History

Juha describes himself as the micro control/digital specialist and Matti as the RF/analog talent, who met in late 2004 to mix their talents to win a receiver design competition sponsored by SRAL (The Finnish Amateur Radio League). Encouraged by the SRAL they made a kit from their competition work, the JUMA RX1. Its success led to a matching transmitter the TX1, followed by a transceiver, the TRX1 and most recently the TRX2

Matti, OH7SV had an idea for a long time about a direct conversion receiver based on a multiplexer mixer. The mixer principle is well known in measurement technology forming a lock-in detector and the commutating filter. It is a very efficient method to recover signals buried in noise. Matti outlined the multiplexer mixer receiver principle (Figure 1) in 1998.

For a number of years Matti's idea lay dormant until 2004 when he got together with Juha and together pursued the concept and eventually formed JUMA to share their work. Shown here (Figure 2) is an early block diagram of their transceiver concept and first project, an experimental direct conversion HF transceiver with DDS LO (VFO). This design eventually led to a more refined and polished transceiver in the JUMA TRX2.

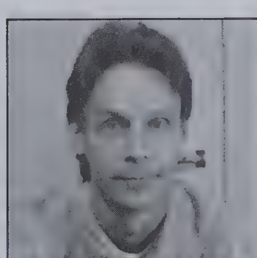
Starting the Kit

When I opened the kit and viewed the contents, I was impressed with the organization and consideration for the builder. What really got my attention was labeling on each bag. Each sticker lists the part number, quantity included, manufacturer marking on it and a picture where it is helpful. With this system even those tiny unmarked SMD parts, i.e. capacitors, were easily identified, making working with such small parts much more enjoyable. The printed circuit boards (PCBs) also speak of the quality of this kit. The glass epoxy boards are silk screened and solder masked, with gold plated pads and traces to avoid oxidation.

I decided my approach to building this kit was going to be a little different than my previous SMD projects. I wanted to try using hot air instead of "hot iron" to do the soldering. So I purchased a low cost Hot Air Rework Station and some solder paste. The method employed with this setup is to place a tiny amount of solder paste on the circuit board pads, nestle the component into the paste and flow the solder with the

The Juma TRX2.

OH2NLT, Juha.



OH7SV, Matti.

TRX2A model covers all HF amateur bands 10-160 meters, RX 100 kHz - 30 MHz
TRX2 model covers 40 and 80 Meter Amateur Bands, RX 2 MHz - 8 MHz
Transmit modes: LSB, USB, CW and tune
Output RF power: 10 W
Built in keyer: Dot priority, Iambic A, Iambic B and straight modes
CW keying with adaptive "VOX" time
Three filters: Wide, Medium and Narrow — user width adjustable
Excellent dynamic range and sensitivity
AGC with slow and fast modes
Dual DDS controlled VFOs with a split TX/RX function
Optical VFO encoder with 480 steps per revolution w/lock feature
Three selectable VFO tuning speeds: Slow/Fast/Very Fast
7 digit frequency display with 10 Hz display resolution
LCD displays RF output, SWR, voltage and PA current
RIT with it's own tuning knob
Graphical S-meter range S1 to S9+40 dBm
Non volatile memory for VFOs, modes, settings and calibration
Width 7.1 in, Height 2.3 in, Depth 7.2 in, Weight 3.7 lbs

Table 1—List of features for the TRX2.

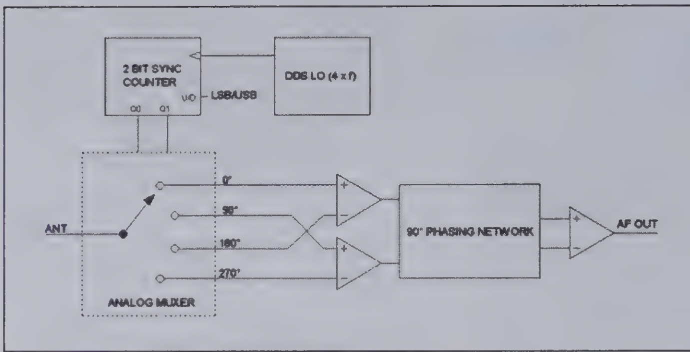


Figure 1—The basic multiplexer mixer receiver.

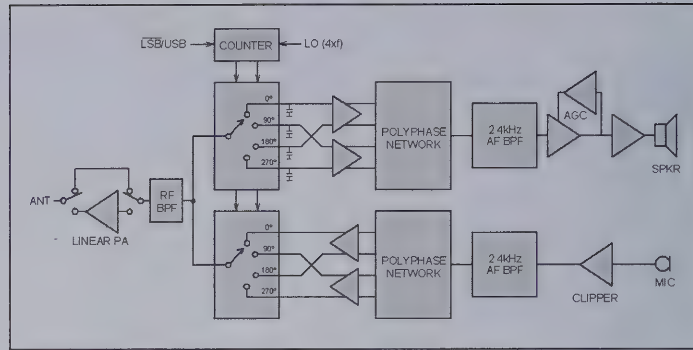


Figure 2. An early block diagram of the TRX2.

stream of hot air from the rework station tool. With a little practice, I found this to be a relatively fast and efficient way to work with SMD. However, I do resort to a traditional soldering iron whenever installing potentiometers and relays, as their plastic housings can be damaged under a hot air flow.

Working with such tiny parts also requires a good set of tweezers, a good light source and a magnification device such as jeweler's loupe. Steady hands help too, so go easy on the coffee.

DDS Control Board

The first board to construct is DDS / Control, which is the heart of this transceiver. It houses the AD9851 DDS and dsPIC30F6014A microprocessor chips as well as the LCD display and user controls. It provides the functions of VFO, I / Q Local Oscillator, CW sidetone and keyer, RS232 serial interface, SCAF filter clocking and digital control signals for the Main and PA boards.

The DDS / Control board attaches directly to the front panel. Since the LCD display, push buttons and rotary encoder are mounted to the board, there is no wiring. The instructions and a gallery of pictures provided on the Juma web pages and in the manual, making the necessary construction steps clear and easy to follow. The DDS / Control board circuitry has its own power supply, a standard TO92 package 5 volt regulator. This allowed me to test the DDS and display functions right away. Happily, it powered up the first time allowing me to watch its attractive blue display as I changed frequency and mode.

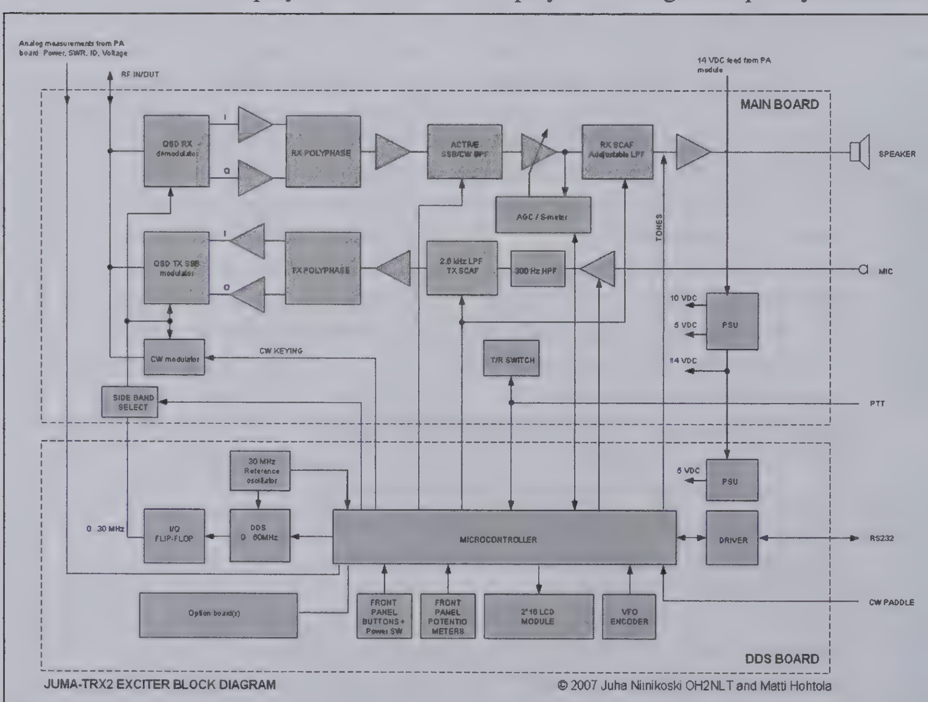


Figure 3—The TRX-2/A Main Board Functions.

I liked the multifunction, rubber push buttons used. They are quiet and have a nice feel to them. The front panel came predrilled and labeled, which meant no fighting with pesky decals.

Main Board

The Main PCB is where all the RF to AF (and AF to RF) action takes place. Using two similar circuits, it demodulates (and modulates) the signals in the unique fashion of this modern direct conversion transceiver. The RX signal is fed directly from the antenna to a double balanced mixer (analog multiplexer) which is controlled by I / Q LO signals provided by the DDS board. There is no RF amplifier in the receive signal path. The demodulation is done directly from RF to AF which provides for very good sensitivity and high dynamic range. The resulting AF signals are then fed into a phasing network to remove the unwanted sideband, pass through bandpass filters and into an adjustable-width lowpass filter. The TX signal is processed basically the same but in reverse. Shown in Figure 3 is a block diagram of the main board functions.

Even though the Main board is well populated, I did not find the component spacing to be problematic during construction. Of course, finding the locations of some of those tiny parts can be a challenge, and I found enlarging the board layout PDF on my computer helpful for my poor old eyes.

Polyphase and Filter Boards

There are two Polyphase boards (one for transmit, one for receive) and one SCAF (switched capacitor audio filter) board that install into connectors on the Main board. These are very quick and easy to build due to their low part count. The

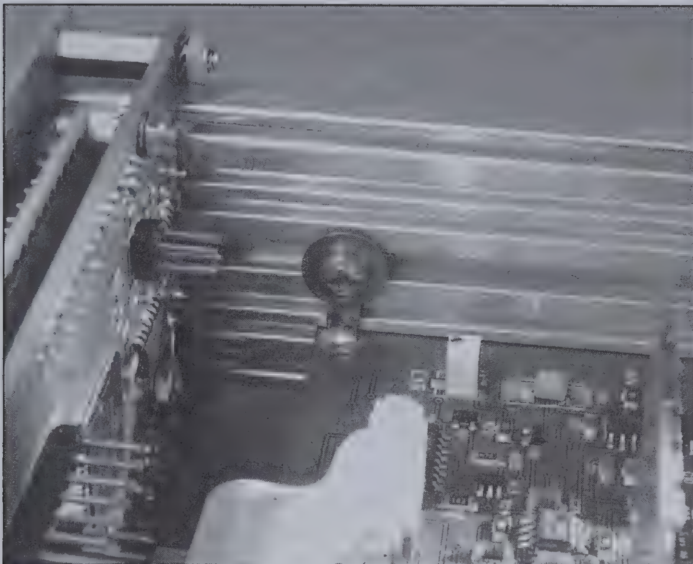


Figure 4—PCB mounting detail.

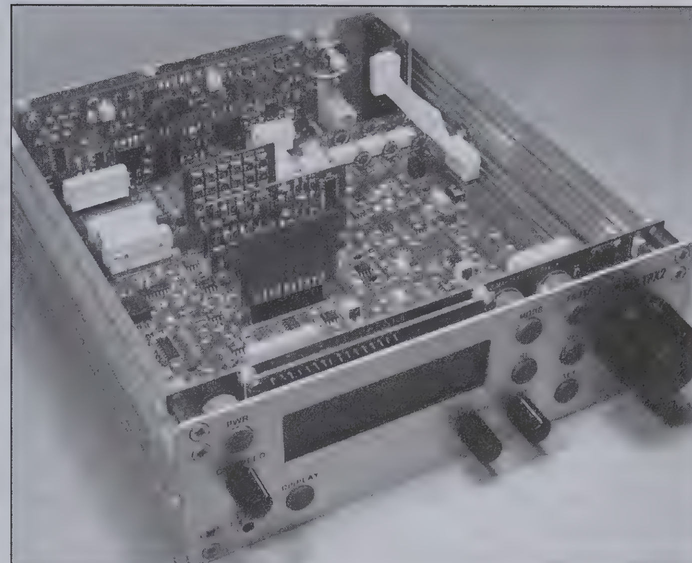


Figure 5—Inside the TRX-2/A.

biggest challenge is holding the tiny boards still to work on them.

PA and RF Filter Boards

Both the TRX2 and TRX2A models use the same Main board, DDS board, Connector Board and chassis so it's simple matter of changing the PA board to upgrade. The All Band TRX2A PA board requires an additional board, the RF Filter Board. It contains the bandpass and low-pass filters and relays to cover 10 through 160 meters and installs next to the Main board. The 2 band PA TRX2 covers 40 and 80 meters and contains its bandpass and lowpass filters onboard. Construction of these boards is not difficult even with six toroids to wind for the all band version and two for the 2 band model.

The PA board (either version) mounts to the rear panel in a well planned design to keep the rigs foot print small. It uses a pair of IRF1510/20 MOSFETs for finals in push-pull configuration. It also includes a SWR bridge using a pair of transformers to sense voltage and current which the DDS computes to display SWR and power in both CW and SSB modes. The antenna and power connectors install next to the PA along with the Connector board. The Connector board is composed of 4 buffered mini-stereo PCB jacks for Phones, CW Paddle, RS232 and AUX links.

Two of the Connector ports are unique for a small QRP rig providing multiple functions. The AUX port can be configured for PTT out (i.e. amplifier keying), PTT in (i.e. footswitch keying) or I / Q output (i.e. to PC soundcard to be demodulated for digital modes).

The RS232 port can be used for rig control with PC programs that support the Yaesu CAT protocol or for input of new firmware upgrades. Firmware upgrades are simple and fast, requiring only a 3 wire cable to a PC serial port and take about 10 seconds to load into the Juma.

The Case for Tying it all Together

Sorry for the pun. I couldn't stop myself because it accurately describes the case they seemed to have designed this little rig around. It is composed of two side rails, the front and rear panels, and the top and bottom covers. The side rails are aluminum with a number of horizontal slots running its entire length which accommodate the PCBs. For the TRX2, it is used to hold the Main Board and the RF Filter Board (TRX2A model). To further stabilize and ground the boards to the rails, the PCBs are designed to accommodate solder lugs to bolt to the rails.

The front and rear panels and the top and bottom covers bolt to the rails to complete the case. The covers are pre-painted, which I liked. My paint jobs never look as good as my solder jobs. The finished covers did concern me when it came to drilling the speaker holes. However, the paint seemed to withstand my alterations without damage.

One last step before tuning and testing was to interconnect the PCBs. In the Juma the boards are linked by parallel ribbon cables, which create a very clean and orderly layout. It was a simple matter to cut the cables to length and press on the connectors.

Final Adjustments and Test

Powering up the Juma after all that work was a happy moment. No smoke. In fact, since I had the antenna hooked up it was instantly receiving signals on 40 meters. That was a good sign indeed. The TRX2 allows a number setting to be fine tuned but only requires four adjustments to get started: PA finals bias, AGC /S meter, and CW and SSB levels. The only tools required are a digital multimeter, a fine blade screwdriver for trimmer adjustment and a signal source. I used an Elecraft XG2 as my signal source. Before transmitting, the final bias must be set and balanced between the two MOSFETs on the PA board. The CW, SSB and AGC adjustments are done on the Main board. All of these settings use the LCD display for feedback during the process. When finished, my power was set to 10 watts for SSB, 5 watts for CW and my S-meter calibrated to S9 for 50 µV of signal. I noticed a little unwanted sideband on some signals. A quick look back at the manual and I discovered there is a simple tweak to adjust the suppression level using the LDC display and a signal source. Afterwards I could not hear any trace of the opposite sideband.

On the Air Results and My Impressions

I finished building the TRX2 (two band version) late in the afternoon a few Sundays ago and decided I had just enough time left to make a few contacts before I deemed it wise to rejoin my family for the balance of the day. I tuned around listening for CQs to answer. The receiver seemed sensitive but quiet. I worked a New Jersey station and a Wisconsin station on 40 and 80 meters respectively. Both stations responded on my first CW call and both returned good signal reports and commented about the nice audio when I told them it was a new rig. This was a good start.

Now it was time to checkout the SSB portion of this rig. I mostly operate CW so I had to hunt around the basement for a mic. After hooking up an old home-made electret mic I tuned and found a K4 in North Carolina calling CQ. He surprised me by responding to my first call with just 10 watts and pleased me with a good report and compliments for my audio.

The next two weeks I spent building the RF Filter and PA boards for the upgrade and squeezed in some time to check into the Michigan QRP Net on CW and meet a couple of friends on 80 meter SSB. The Juma's speech processor proved quite helpful to my 10 watts to overcome the band noise.

The upgrade required adding the RF Filter board, swapping out the PA boards and setting the bias to the finals. The only difference in performance appeared to be a larger choice of frequencies. I did notice an increase in sensitivity below 2 MHz, as expected, which brought forth a lot more broadcast stations to enjoy. A quick contact to Barbados on 20 meters netted a 589 report and proof the upgrade was functioning in transmit mode as well.

The weekend of the ARRL International DX Contest did expose a minor problem with the TRX2 on 15 Meters. Saturday, slowly tuning around a very dead band I discovered several DDS-generated spurs. They were very narrow; just a couple hertz wide, but they concerned me. However, in the afternoon the band opened, exploding with contest signals and it dispelled my fears. I found the DDS tones were so narrow they did not interfere, as I was able to work DX stations up and down the band. The Juma design team is currently evaluating a DDS upgrade to alleviate this problem, which is only apparent in the 21 MHz band of the TRX2A.

Operating the Juma TRX2/A

The TRX2 has an attractive, easy to read blue/white LCD and uncluttered front panel. Its simple user interface and limited number of buttons and knobs make it quick to learn and easy to use. The front panels controls include: MIC (stereo jack), knobs for Tuning, RIT, CW SPEED, AF GAIN and buttons for PWR, DISPLAY/CONFIG, MODE, FILTER, RIT, VFO A/B (and split), FAST/VFAST (and slow—for tuning speed).

Most of the front panel buttons perform multiple functions offering additional user controls accessed from a menu displayed on the LCD. A short push of the CONFIG/DISPLAY button changes the LCD to display the configuration menu. Here the user can quickly set the AGC speed, filter width, internal keyer mode, CW pitch, speech processor ON/OFF, noise blanker (a future option) ON/OFF, CW pot function options, RS232 protocol, RS232 speed, and AF input select.

Keyer, Phone, RS232, and AUX, all stereo jacks, are available on the rear panel, along with the Molex power and BNC antenna connectors.

The Filter button offers a choice of 3 usable widths adjustable from 4 kHz down to about 650 Hz. The interfering signals just seem to drop away with no perceptible loss to the desired signal strength.

My Conclusions

The kit was a very enjoyable build. The physical design was obviously well thought out and engineered as all the bits and pieces fit together without a struggle. Although not a beginner's kit, the TRX2 is not difficult to construct if you've had some SMD experience. The professional packaging of the kit with its unique partlist labeling makes taking inventory a breeze and eliminates part identification problems. The case comes painted and labeled but the rails and cover do require some drilling. The only unusual tool I might suggest is a hand countersink tool for countersinking the side rail and speaker holes. However, a common metal drill bit could be used here as well.

I find the looks of the TRX2 appealing. It's quite apparent that a great deal of time and engineering has gone into its design. This radio can fool you with its outward simplicity. It has few bells and whistles. No frequency or band memories except for dual VFOs. It doesn't have a large number of controls nor does the display present multitudes of information as many of us American hams have come to expect of our radios. However, the JUMA TRX2 makes efficient use of its controls and display to provide a surprising amount of features and control. At first, I thought it would be tedious to change bands without a dedicated button. After some use, I discovered this wasn't the case. A long push on the VFO speed button (VFAST) and the tuning speed jumps to 4.8 MHz per revolution to effectively span large frequency ranges quickly. The VFO encoder has two other rotational speeds, slow at 4.8 kHz per turn and fast at 48 kHz per turn. The encoder tuning step rate is 10 Hz, 100 Hz or 10 kHz.

I found the SCAF circuit to be effective and impressive. When I tune in on a weak signal and engage the filters, the other signals seem to just drop away, leaving the desired station without perceptible loss in its signal strength from 4 kHz down to about 650 Hz of its range. From 650 Hz to 500 Hz, the bottom of the adjustable range, there is signal strength drop off.

CW keying uses an "Adaptive VOX" technique which adapts the hold time to keying speed. It's well implemented as it has never given me pause to think about it during use. The T/R relay is mechanical but quiet. The CW contacts I've had have reported a click-less, nice sounding note.

The TRX2 produces great audio on receive and by all reports a very nice signal on transmit as well using a simple, inexpensive electret microphone.

The receiver is very hot with a claimed sensitivity of about –130 dBm and dynamic range of over 100 dB. In my comparisons it hears as well as my Elecraft K3. Having wide band coverage is a real bonus in such a small rig and the quiet, clean audio that Direct Conversion delivers make it a pleasure to listen to.

As if you can't tell from this review, I am well pleased with the Juma TRX2.

—Pete, WK8S

Confessions from a New QRPer

Mitchell Gill—NA7US na7us@yahoo.com

It has only been in the past year and with the encouragement of Mr. QRP, Rich Arland (W3OSS), that I have delved into the world of low power. I tried some QRP while I was in Iraq but conditions were so poor that I ended up running up the power just to make a few contacts. But there is something about making contacts with only 5 watts or less that gets into your blood. It is almost as exciting as being a Novice again in the late 60's making those first DX contacts as the tubes glowed around me.

I was hooked but I had to make a few changes. The biggest change was that I had to build a decent antenna and my luck at building anything other than models (I always smeared the glue) could be best compared to my cooking. It may look good but the dogs won't even eat it. Somehow I managed to build a 5 element end fed Bobtail that worked. You may understand the momentous accomplishment this is if you knew how I almost burned the house down building a copper two meter J pole with a blow torch. I did finish the job after the fire department left but it never seemed to work right. The Bobtail however tunes from 40-6 meters with a tuner and I now feel empowered to build a three element for camping but my XYL does not like me playing with anything that produces heat. I built the five element when she was shopping one day and she only noticed it last week.

My second change is that I had to do re-organize my shack.

Now my shack is not the same as the majority of you. I have seen those pictures of your decorated spare room in the house with the large desk and shelves with neatly stacked radios and a computer. I tried to do that but after a few weeks it would turn into the junk room with ham magazines on the floor and wires through the windows. Being happily married and wishing to remain so, I had a choice, move the radios to some location my wife never visited nor saw, or move myself to some other state. So I moved to the shed. It is a shack in the very strictest definition of the word; a crude building.

Many of you old timers can remember the ham radio cartoon showing the dilapidated shack and the goofy looking guy with wires all around him. That's me except that I don't occupy more than an 8x4 section in the corner. No window, barn doors that let in the cold, and a portable kerosene heater that barely keeps my feet warm after the smoke dies down. During the winter my teeth will chatter CQ before my gloves ever touch the key. The floor is made of plywood and after years of rain and living in the wet Pacific Northwest it has become soaked. It is beginning to warp. Instead of calling it my Ham Shack, I call it my mini expedition. It helps me to visualize those DXpeditions to the remote islands near Antarctica. I can almost feel the biting winds as it whips through the tents on the rocky shore. All I need is a cot to complete the picture but I don't have the room with all the stuff we store. Besides that, I would have to clean up the magazines on the floor and my XYL might start thinking that I should stay there more often.

I would love to have a set up like yours. I could if I would settle down but I am impatient. I want to operate and then straighten the area out, but instead, I operate and think that I will do cleanup at some later time—and the cycle repeats. I end up moving cables out of the way to get to the key or searching for the microphone. I have a computer for PSK31 but the power supply is so noisy that it overrides most of the signals. I have a laptop for logging and wireless internet but it keeps finding my neighbors wireless router instead of mine. That was OK until he password protected it and now I have no internet. Drat!

I am not someone who avoids doing things like a procrastinator. To procrastinate means, to me, that you have to think about it real hard and then make a conscious decision to find something else to do. Nope, I just don't do it. No contemplation, no thoughts, I just don't do it. I would just rather operate by moving a few cables out of the way, chatter a little before pounding the brass, and look at pictures of beautiful organized stations like yours. You see, I do believe in osmosis and if I sit here long enough the station will slowly and magically change into a station just like yours. The only problem is that I have been here a week and it seems to be going in the opposite direction.

Oh well. There's always tomorrow. Hey, at least the antenna works!

NA7US was first licensed in 1969 as WN4TUT, Mitch is now an Amateur Extra lives with his family in the Pacific Northwest and is a full -time soldier for the Army National Guard as the Subject Matter Expert in Communications for the Joint Operations Center. You can send him comments (or ask for his advice) at na7us@yahoo.com..

●●

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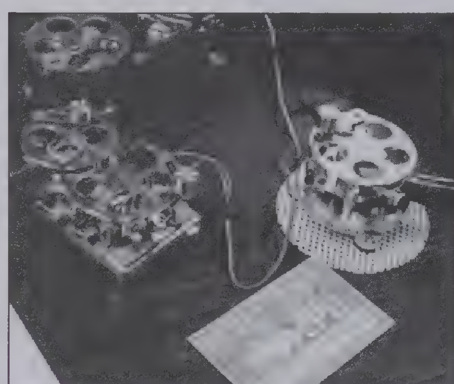
Registration and getting acquainted begins on Wednesday evening. Seminars are most of the day Thursday, with "meet the speakers" and an open room for some casual show and tell, vendor displays and plenty of time to swap tales that evening. Most of Friday daytime is open to attend the Hamvention® and visit the QRP-ARCI Toy Store. Friday evening activities usually include "show and tell", vendor displays and maybe a judged home brew contest. Most of Saturday is again open for the Hamvention, and we have a great social event, banquet, awards presentation and door prizes that evening. Sunday is the Hamvention, and check-out.

Most of the speakers for the seminar have been contacted and confirmed. We'll have a "meet the speakers" social gathering after the seminar, where you'll have an opportunity to meet, question and discuss QRP with the speakers.

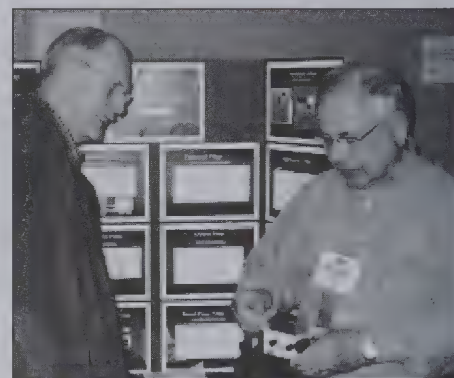
Don't miss out on the show and tell. You'll have an opportunity to bring out your QRP related projects and put them on display. Your contemporaries will have a chance to roam through the displays and see the excellent craftsmanship used in these special exhibits.



We'll have a build-a-thon for a QRP project, a judged project contest and it shouldn't surprise you to find a contest or two during the weekend. We've had QLF, split paddle, and other fun activities in the past.

QRP related Vendors are invited to exhibit both Thursday and Friday evenings. We're sure you'll find many special FDIM discounts.

In the past, the hotel has been accommodating with discount meal tickets. You'll find fast food restaurants across the street from the hotel.



This is preliminary information. A complete schedule and list of activities will be posted on the web site as we move through the process.

Dress is casual for all events.

We will again be at the Holiday Inn, Fairborn, OH. Reservations and special room rates for FDIM will be available after the first of the year through www.QRPARCI.org. Remember, all discounted hotel rooms are released only through QRP-ARCI. Instructions will be posted as soon as the Hotel is ready to start processing our Room Block.

Questions or comments:

Norm Schklar, WA4ZXV
FDIM2008 Chair
fdim@qrparci.org
ph 770-313-9410

Last updated November 30, 2007

Thursday: a full day of seminars

Saturday evening: Awards Banquet Door Prizes

FDIM 2008 XIII

Four Days in May
May 15-18 2008
Thursday thru Sunday

Friday daytime, take abreak and attend the Hamvention

Thursday evening: Meet the Speakers

- Registration and getting acquainted begins Wednesday evening.
- Seminars are most of the day Thursday, with "meet the speakers" and an open room for some casual show and tell and plenty of time to swap tales.
- Friday daytime is open to attend the Hamvention® and visit the QRP-ARCI Toy Store.
- Friday afternoon and evening activities usually include "show and tell", vendor displays and a judged home brew contest.
- Saturday is again open for the Hamvention, and we have a great social event, banquet, awards presentation and door prizes that evening.
- Sunday is the Hamvention, and checkout.

Wednesday evening Registration and get together

Thursday evening: Casual Show & Tell

FDIM Registration and Hotel Reservation available on www.qrparci.org

Friday afternoon and evening: Vendor Night, Judged Competition, Homebrew Displays

Much More! Watch the web site www.qrparci.org

Home Brew Contest	Build-a-thon
Banquet	Seminars
Meet the Speakers	Vendor Displays
Discounted QRP Products	Door Prizes
Discounted Hotel Rooms	Complimentary Breakfast
Hamvention just across town	Nearby Restaurants
New Product Announcements	Spouse Program

This is preliminary information. Some changes will most definitely occur. Please check the web site, www.qrparci.org, for the latest details and registration information.

Timothy A. Stabler—WB9NLZ wb9nlz@yahoo.com

Photos from the Bath (UK) Buildathon.

I am sure that most of us have done all the "winter kit-building" we intended to do, and now it is time to think about those outdoor projects. To be honest, I did not get as many kits built as I would have liked to do, but did pass my H&R Block course and got into tax returns, at least for a little while. First year people do not work the whole tax season at H&R. But, I did have a good time and learned a lot more than what the course taught. If I get my re-hire hours in, I have been asked to return next year. For those that did not know this, all H&R Block employees must take 24 credit hours of tax work to be rehired.

Other QRPers were busy, however, and here are some of their stories:

A Buildathon in Bath, England

I did hear from Steve Hartley, GØFUW, about his recent Buildathon. Although popular in the United States, this was thought to be the first in the UK.

The first Bath Buildathon took place with 12 amateurs building their first transceivers. Some had been licensed for years but had never built anything while others were Intermediate students from the Bath radio classes. Builders traveled from as far away as Wolverhampton, East Grinstead and Southampton showing that there is still a widespread interest in homebrewing in the UK.

The kit chosen for the Buildathon was the Walford Electronics Brendon 80m DSB transceiver (www.walfordelectronics.co.uk) and proved to be very popular. Everyone commented on how well the kit went together and all were extremely pleased when they received their first signals. Not everyone finished the transmit side before the event closed but those that did enjoyed QSOs across the room with Tim Walford, G3PCJ, the kit designer. Tim very kindly donated a prize to Brian Jones, M1ZEZ, who was the first to complete the kit on the day.

Feedback from the builders was extremely positive and most are ready to do it again soon. Steve Hartley, GØFUW, who arranged the event said that it had been a huge success and that he would encourage other tutors and clubs to have a go with their own Buildathon. Steve was assisted by Mike Coombs, G3VTO, and Lewis Thomas, G4YTN, and all agreed that team work was the key to success.

Colorado QRP Club

I also heard from Peter Inskeep, NO2D, the president of the Colorado QRP Club. He wanted to report on last year's Field Day as that is coming up.

Traditionally, the Colorado QRP Club has had a dedicated group of very, very serious Field Day participants. They drive up into the mountains to an excellent location, from which they launch an all out effort to win first place.

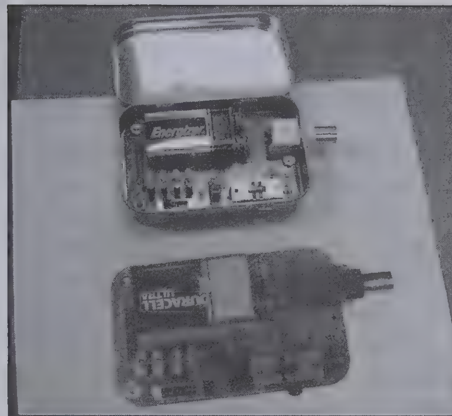
Because the effort is so intense, it does not leave a lot of room for more casual operating. So, the Club resurrected an old plan, which was to have a second Field Day effort, named, appropriately, "The Aloha Field Day" event. Thus, the Club ran two different Field Day sites. Both sites were very popular, so it is planned to do this again this year.

While the serious Field Day team is up high in the mountains Southwest of Denver, the Aloha Field Day site is located at the Cherry Creek Park right in Denver. It is easily accessible by the large throngs that inhabit the park on summer weekends. The modest antennas serve as beacons for the public. Curiosity seekers come to watch, listen, and to participate. A number of people who had never picked up a microphone stopped by to say "Aloha, this is ABØCD, calling CQ Field Day."

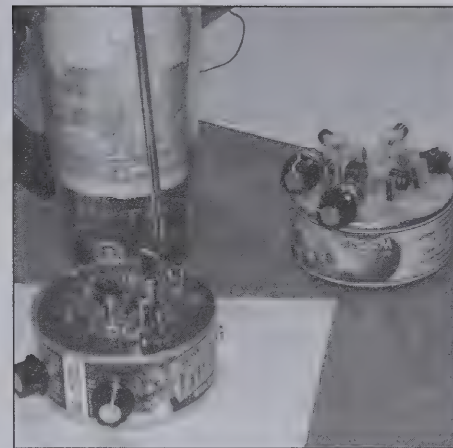
Great fun was had by all at the Aloha Field Day site. While the score was pretty close to the bottom of that class, everyone's enjoyment was pretty close to the top. Meanwhile, the serious Field Day site, WØCQC, racked up near-top honors in its class, which added greatly to the joy of those who roughed it up in the mountains to make that happen.

Peter writes that he is not sure how many clubs are able to launch two distinct Field Day efforts. The Colorado Club is fortunate enough to have more than enough enthusiasm, and expertise, to do just that. Oddly, though, one group was not able to contact the other and get the "other half" into the respective logs. Peter guesses they were too far apart for ground wave, and too close for skip. They are looking forward to doing the same again this year. Only this time, the Aloha Field


Members of the Midwest QRP Group working on their S-9 kits.



Some completed S-9 kits—nicely done, guys!

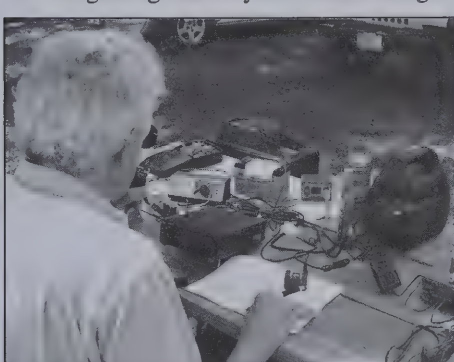

Dar's, W9HZC, Sudden receiver.

Day site plans to put up bigger and better antennas. Even so, they don't expect to even come close to the serious Field Day group. After all, if Aloha beat out "Serious," then serious would not be any fun any more, would it?

Homebrewers QRP Club

Darwin Piatt, W9HZC, reports that he has put out the second HBQRP Newsletter. Personally, I think it to be an interesting publication. You can see the first edition, which includes my visit to the group, on their website (http://www.qsl.net/hbqrp). If you want to see the second edition, email me and I will send it to you.

The January 12th meeting of the Midwest Homebrewers and QRP Group started on time and coffee was hot when everyone arrived. Five folks received new NorCal S-9 kits, the signal generator kit, and a complementary Altoids Tin and the work began. Some of the group did break for some good food and drink (which is why the gatherings are held at the pizza place) but construction continued throughout the get-together. By the end of the get-together, three of the S-9 kits were done, two of which were tested and could be heard on Dar's little Manhattan version Sudden receiver clear across the room. Nice!


Darrel, KØAWB, and his 20-meter version of the Small Wonder rig.

Darrel, KØAWB, brought two of his Small Wonder rigs, one on 30 and one on 20 and is finishing the 40 meter version. Nice little rigs.

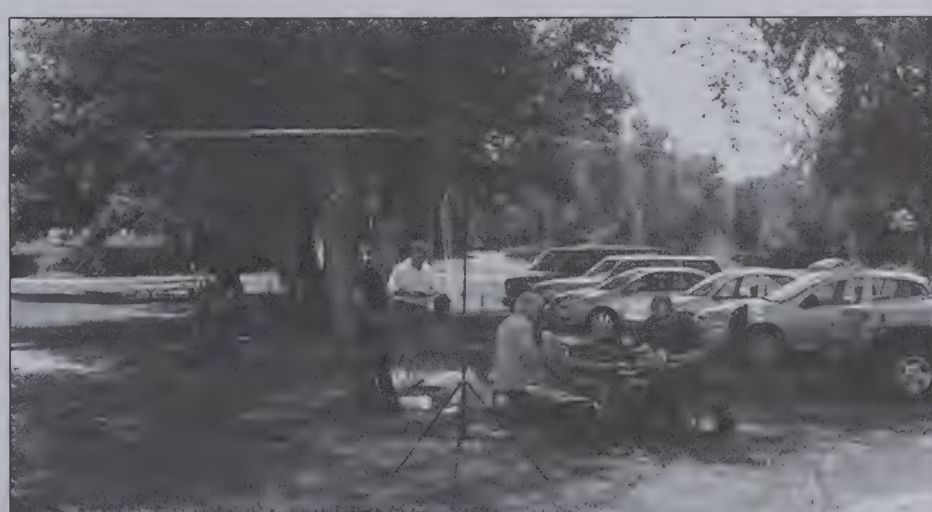
Dar, W9HZC, showed up with two versions of the Sudden receiver, one the Sudden Storm from Rex and the other one a Manhattan style. Doug, KI6DS, had provided the group with little bags of parts to build these receivers a while back. Doug has been a good supporter for the group and the group appreciates his efforts very much. They like his kits too!

Not sure if any project has been decided on for the March meeting, but a motion was put to the group and they will be going out to the local field for the May 10th get-together and do a little antenna testing. Their first antenna day this past summer was great fun, little warm but fun. Some pictures are available on the HBQRP web site or at http://picasaweb.google.com/Dar.W9HZC.

Several of the members of the group are also planning for a trip to Joplin, which should be a fun trip.

The group meets on the second Saturday of the odd numbered months of the year in Ashland, NE, just off Highway 6 and a few miles off of interstate 80. Just turn south off of I-80 at the Strategic Air Command Museum. You can't miss it.

Send news about your local QRP club to Tim, WB9NLZ at: wb9nlz@yahoo.com. Share your stories and show other QRP clubs a few new ideas for their meetings and activities!


Last summer's Antenna Day at the Midwest QRP group.

QRP ARCI Awards

Jeff Embry—K3OQ awards@qrparci.org

It has been a fairly quiet quarter regarding the amount of awards coming in. My hope is that this is merely indicative of the present state of the solar cycle.

That being said there is still a lot of fun to be had on the bands running at QRP levels as indicated by AD7HI's milliwatt award (see below). And, for even more fun, have you considered entering a contest running QRP? Maybe you won't wind up in first place, but you can still have a lot of fun and add quite a few contacts towards QRP ARCI awards. As any old contester will tell you, even the top stations in a contest often run out of new contacts toward the end of the time allowed. That means you have a lot of hams with very good stations trying extra hard to hear every little whisper of signal energy. Such a deal! Help them out by entering the contest with whatever time you have available, and you will probably be rewarded with contacts from a lot of places that are not ordinarily on the air. A great place to start would be our own QRP ARCI contests. When you gain some confidence, then some of the larger contests might offer even more contacts. Give it a try!

Now for awards for this Quarter: Four 1000-Miles-per-Watt certificates were awarded, and thanks to NU4B we have had our first submission for 5 Band QRP-All Continents.

I have had a number of emails from various folks concerning rules for various awards. As a reminder, we now only require a list of the contacts you have made that qualify you for the award. And if there are any questions concerning the rules for any award please check the Club's website at http://www.qrparci.org and click on Awards. The general rules are also included at the bottom of this page, but please email me if there are any further questions.

That's about it for this quarter. Keep those submissions coming.

KMPW

3003 HSØGBI worked G3ICO on 14 MHz CW for a distance of 6081 miles per watt.

3004 K6UIZ worked G4XRV on 14 MHz CW for a distance of 5390 miles per watt.

3005 WA4JA worked SV1DPI on 21 MHz SSB for a distance of 5686 miles per watt.

3006 AD7HI* worked WA3SLN on 10.1 MHz CW for a distance of 3602 miles per watt.

*Indicates milliWatt endorsement

5 Band QRP-All Continents

1 NU4B provided documentation to confirm 5 Band QRP-All Continents were worked.

General Rules for all Awards

1. All awards offered by the QRP ARCI are available to any licensed amateur radio operator worldwide. Awards are also available to SWLs on a heard basis. All contacts must have been made running a maximum of 5 watts CW/DATA or 10 watts SSB/Voice.
2. The fee for all awards and certificates for W/K amateurs is $4.00 US or for non-W/K $5.00 or 10 IRCs. If IRCs are used they must be the current IRCs in the blue color (4 × 6 inch) format and must have the proper Post Office stamp on it. Older yellow IRCs are not valid for the awards.
   Make checks or money orders payable to Jeff Embry. Cash is acceptable (US Dollars only) but is sent at your own risk. For the KMPW award, if you would like a certificate sent to the amateur at the other end of your qualifying QSO, please enclose an additional $4.00 (W/K) or $5 or 10 IRCs (non-W/K). An SASE is not required. If you send one, it generally will be returned with your award.
3. Confirmations, in the form of QSL cards or other electronic logbook data, such as EQSL or LOTW, are not required for all Awards offered by QRP ARCI.
   With your application please include a listing of claimed stations complete with log data and a GCR Form signed by two amateurs attesting that they have examined your logs and verify your qualifications for the Award. Your list should conform to the individual format of each Award as listed.
4. Endorsement stickers are no longer available. Depending upon the award, a new certificate will be issued with the updated info on it. For example, if you have WAS20, and move up to WAS30, a new certificate will be issued. A Natural Power certificate may be claimed for any award when using a power source other than Household Electricity, Motor Driven Generators or Batteries.
5. A note on multiple band awards. The 5 Band QRP-All States, QRP-DX and QRP-All Continents Awards can be for any 5 of the HF amateur bands including 30, 17, and 12 meters. Please note that if you include 30 Meters as one of your 5 bands and you are claiming one mode (CW or Data), the other 4 bands must also be all CW or all Data. Please remember that no SSB/FM operations are permitted on 30 meters.
6. Any questions about the Award Program can be directed using email at awards@QRPARCI.org

A Homebrew 30 Meter Radio in a Weekend

Harold A. Smith—KE6TI harold.smith@gmail.com

Most weekends my wife and I try to do something together. One dreary weekend in January, though, my wife had brought a lot of work home, and was going to be busy both days. I was on my own. While I was waiting for some parts I'd ordered for the big project radio I'd been working on, I had been browsing my little technical library. I had picked up some ideas, so I decided to see if I could build a radio from scratch in a weekend.

Fortunately, I have a reasonably deep junk box. I have been building radios, and scrounging parts for radios, since dinosaurs ruled the earth and antennas were made of wood and stone. (Trust me, aluminum and copper are a great improvement.)

I decided to try for a thirty meter radio, because I had a crystal at 10.111 MHz, scrounged from a defunct satellite receiver. I built the transmitter first, because I thought it would be easier, and thus would give me more nearly instant gratification.

The circuit I used for the transmitter came from my trusty copy of *Solid State Design for the Radio Amateur*. It is the circuit that, I think, has come to be called the Little Joe, an excellent two stage design by W7ZOI.

I made a few changes from the SSD version. The result is shown in Figure 1. I wanted to use the crystal in a variable crystal oscillator (VXO), so I modified the oscillator for that. C2 and C5 are both 100 pF, larger than I would otherwise have used in those positions. Larger feedback caps seem to allow more tuning range in a VXO. I added a 15 µH molded choke and a variable cap that I estimate had a maximum capacitance of about 100 pF in series with the crystal. Those gave me tuning from about 10.107 down just to the lower edge of the band. Not a huge range, true, but better than being stuck on a single frequency.

I used an untuned transformer between the oscillator and the final, though I kept the same 9:1 turns ratio. I figured if it did not work I could tune it, but it seems to work just fine. Finally, I changed the output low pass filter to a 5-element one for more harmonic suppression.

I also used transistors that I had available in the junk box. The oscillator is a PN2222, though any similar transistor ought to work. For the final I used an obsolete National NSD102, a supply of which I found at a hamfest a few years ago. In the original version W7ZOI used a 2N3553, also obsolete, but possibly more obtainable, since it was made by more than one vendor. And there are many transistors that are still easily available that will work.

Finally, I used a Japanese PNP for the keying transistor, but a 2N2907, 2N3906, 2N4403 or MPS-A56 will work just as well. Note that, as built, the final is keyed and the oscillator runs all the time, which may or may not be optimum. It will certainly make it easy for the receiver to spot, but might overload it.

The transmitter worked when I first powered it up, putting out a clean-looking 1.5 watt sine wave into a 50 ohm dummy load. Figure 2 shows the finished product. As is the usual case, I used "ugly construction" to make the little rig. Total building time was under two hours, which left a big chunk of the weekend for a receiver.

The receiver, a direct conversion type, started with an idea gleaned from a presentation by Rev. George Dobbs, G3RJV, at FDIM 2005, and documented in the Proceedings. One of the circuits he mentioned was the two-diode frequency-doubling mixer, which is a circuit in which the local oscillator (LO) is injected at half the working frequency. The mixer then doubles the injection frequency. The advantage is that the LO does not run at the signal frequency, and is thus immune to pulling. I had seen the circuit before, but had never tried it. This seemed like the opportunity. Figure 3 is the resulting receiver schematic.

I built the LO first, a Clapp variable frequency oscillator (VFO) that covered 5.05 to 5.075 MHz, which when doubled

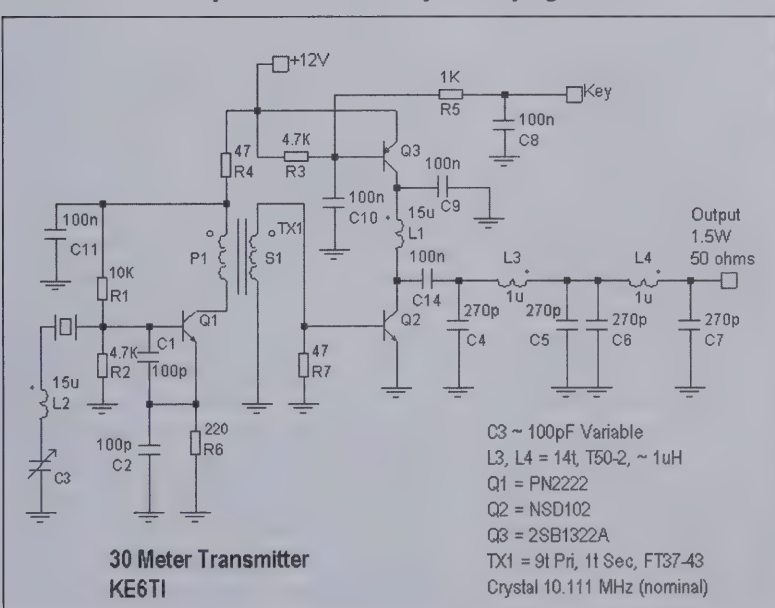


Figure 1—The weekend transmitter schematic.

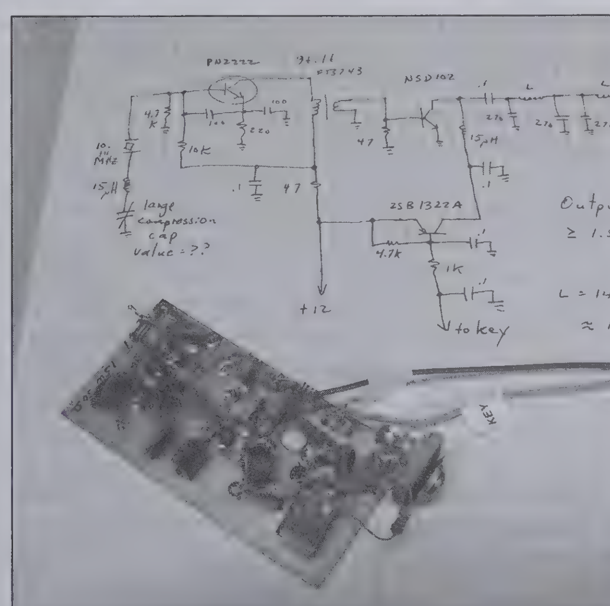


Figure 2—The transmitter board completed.

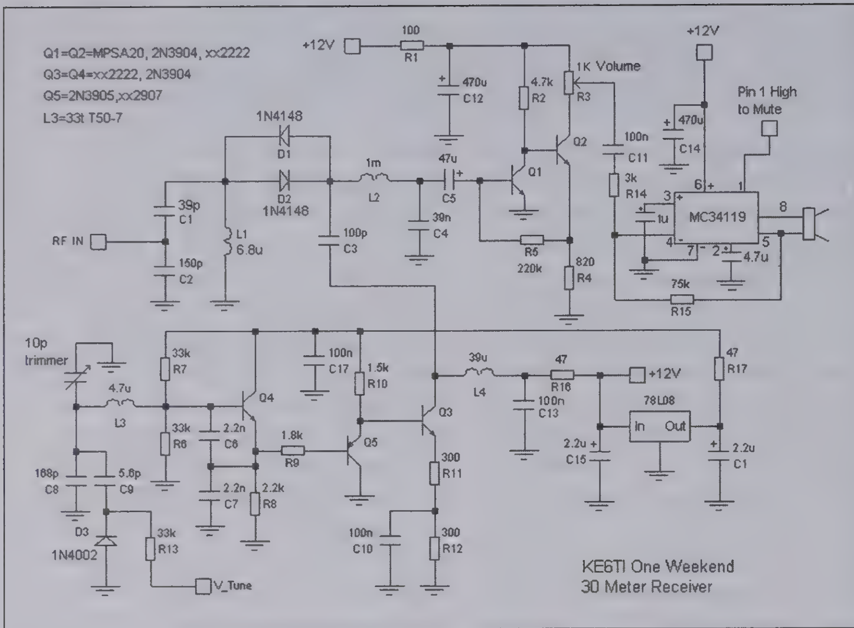


Figure 3—The weekend receiver schematic.

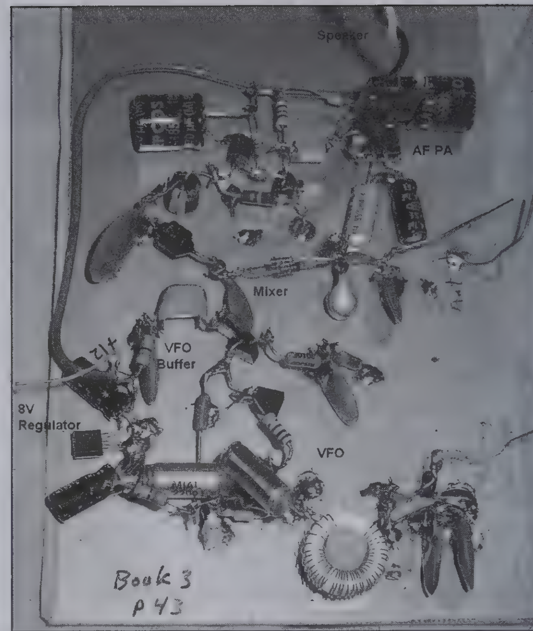


Figure 5—A view of the weekend receiver from another angle.

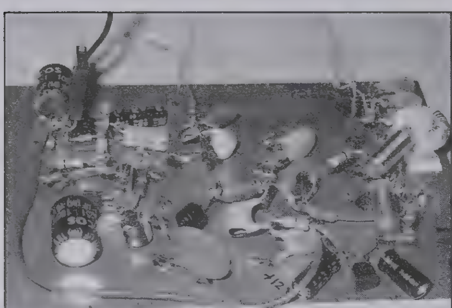


Figure 4—The weekend receiver completed.

just covered the 30 meter band. I used a pre-wound toroid from the junk box for the VFO's tank inductor, and tweaked the surrounding values to get the frequency range I wanted, compressing and expanding the inductor's windings a bit to fine tweak the range. The two 2200 pF caps appear to be polystyrene, but that's only a guess based on their appearance. I decided to tune the VFO with a voltage, and put a 1N4002 to work as a variable capacitance diode, which worked fine. (Had it not, I would have tried a real varactor, or perhaps the C-B junction of a bipolar transistor.)

I didn't measure the oscillator's stability, but it sat on a signal from one of my generators with no great pitch change for several minutes.

Theoretically, the mixer would not have pulled the VFO, but I am constitutionally incapable of building an unbuffered VFO. I added a simple, direct-connected two stage buffer, taking the output from the second stage's collector. I also added a small three terminal regulator to keep the VFO's supply voltage constant.

I used a single tuned circuit between the antenna input and the mixer, arranged for a bit of impedance step up. I didn't design that network; instead I simply scaled it to 30 meters from the one shown in the FDIM *Proceedings* article. The pair of diodes that comprise the mixer run from the top of the input network to a lowpass filter and the LO injection.

After the lowpass filter is a two stage audio preamp, also lifted from the *Proceedings*. I did not include a volume control when I was building the receiver, but the collector resistor in the second audio stage is the perfect place for one.

The final stage in the receiver is an IC-based audio power amp. I used an MC34119, which is made by Freescale Semiconductor (formerly Motorola) primarily for use in telephones. (The IC I used is in a DIP package, but it appears that only the SOIC package is still available from Freescale.) Again, I used it because I had it. The LM386 is much more available and should work as well. The MC34119 drives a small speaker lifted from a junked computer. The MC34119 has provision for muting by bringing pin 1 to the supply voltage, but I decided not to make use of that feature.

I did not really expect much from such a simple receiver, built so quickly and with so little analytical work on my part. But bench tests showed it could easily hear a 1 mV signal from my URM-25, and it had no trouble copying several 30 meter signals with no more antenna than a three-foot clip lead in my basement. I have not yet put it on my big outdoor antenna.

I built these two, transmitter and receiver, the way I build pretty much everything—ugly style, on a piece of scrap PC board material. See the pictures to understand why it is called 'ugly,' but it works, and it goes together quickly. The total time invested in these two, for building and testing, was about eight hours, most in the receiver. I have built a lot of radios through the years, so I have a bit of experience, but I was still surprised at how well these worked.

Just for completeness, I took a couple of hours on a second weekend and put the two boards into a cabinet I found in my junk box. (I had to come up with a back panel, since the box lacked one.) Figure 6 is a block diagram of how the whole thing went together, and Figure 7 shows the finished product. I added reverse polarity protection to the incoming power lead, and swapped out the mica trimmer in the transmitter for a small plastic variable. I

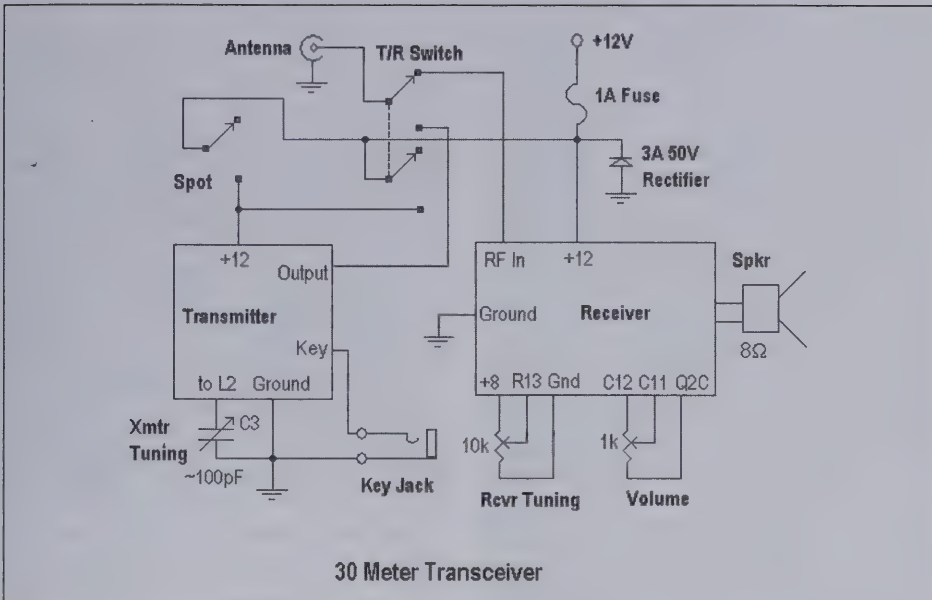


Figure 6—Transceiver interconnections.

Figure 7—The completed transceiver, installed in a "not so ugly" enclosure.

mounted tuning controls, the volume control (in place of R3), the speaker, a key jack and two switches on the front panel. One switch is for transmit/receive (T/R) switching and the other is for spotting. The T/R switch removes power from the transmitter when in receive, as well as switching the antenna from one board to the other. There is no provision for sidetone, which, in my station, comes from an outboard electronic keyer.

This is not really a construction article. I do not expect anyone to try to duplicate what I have done, but I wanted to show that building a radio is not necessarily a long, difficult project.

References:

1. http://www.qrp4u.de/index_en.html This is an interesting site generally. But see the "Some Useful Tables" section for the source of the transmitter's low pass filter.

2. FDIM 2005 *Proceedings*: 4. "Amateur Radio In Reduced Circumstances", Rev. George Dobbs, G3RJV

3. http://www.gqrp.com/ "A Short Guide to Harmonic Filters for QRP Transmitter Output." Rev. George Dobbs G3RJV. This is another table of low pass filters for QRP transmitters.

4. http://www.arrl.org/tis/info/pdf/9902044.pdf. Still more low pass filters.

5. http://www.aoc.nrao.edu/~pharden/hobby/_lpf_pa.pdf. This is an excellent tutorial on transmitter output filters.

6. http://www.agder.net/la8ak/c21.htm. LA8AK has loads of information in these pages. The link here goes to a page that includes information about the frequency doubling mixer I used in the receiver. (You'll find almost exactly the circuit I used labeled "Bad Construction." According to this site, I need to terminate the mixer better, but that is for later experimentation. For now, it seems to work well enough, at least on small signals.)

UPCOMING QRP ARCI CONTESTS
MARK YOUR CALENDARS!

Hootowl Sprint
May 25, 2008

milliWatt Field Day Contest
June 28-29, 2008

Summer Homebrew Sprint
July 13, 2008

Silent Key Memorial Sprint
August 16, 2008

End of Summer Digital Sprint
September 14, 2008

Using VHF to Track Down Power Line Noise

Bob Witte—KØNR bob@k0nr.com

In this issue of *QQ*, we'll take a look at how your handheld VHF rig can improve your HF station performance. Huh? How does that work? Many of us face the problem of noise coming from the power lines interfering with our HF operations. We can use a VHF or UHF receiver to track down this noise.

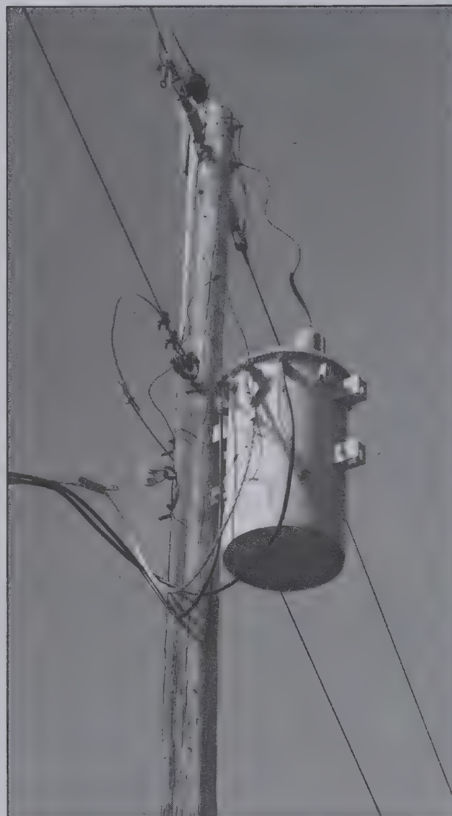


Figure 1—This is a typical power pole with a transformer mounted to it. Power line noise is a result of a poor electrical connection or loose hardware.

Figure 2—A Yaesu FT-817 is a versatile radio for tracking broadband interference.

Broadband Noise

Power-line noise is generally broadband in nature. The noise occurs in the form of "sparking" on the power line, usually the result of a loose or intermittent connection. While there are other mechanisms for generating noise from power lines, 90% of the noise radiating from power lines is due to sparking (see *AC Power Interference Handbook*, Chapter 1).

Short bursts of electrical current generate broadband noise, extending over a wide range of frequencies. A typical power-line spark has a rise time of about 2 nanoseconds. The rule of thumb for relating rise time to bandwidth is:

$$\text{Bandwidth} = 0.35 / t_{rise}$$

A spark with a rise time of 2 ns will have a 3-dB bandwidth of 175 MHz. This is only an approximation, since the shape of the radiated bandwidth depends on the waveform shape of the spark. In practice, the spark energy will exceed 175 MHz and may go as high as 1 GHz.

This creates an interesting challenge and an opportunity for tracking down power line noise. Often we will first experience the noise on the HF bands (or lower). One common technique is to use a portable AM broadcast receiver to listen for power line noise, walking around looking for hot spots. Since the radiated energy of a spark tends to decrease as the frequency increases, we'll usually hear the offending noise clearly on the AM broadcast band (roughly 520 kHz to 1610 kHz).

The wavelength of the signal at 1600 kHz is 187.5 meters—it is going to be difficult for us to carry around a highly directional antenna for that wavelength. Even more important, the noise source will be difficult to pinpoint as it will tend to radiate for a considerable distance up and down the power line. Think about modeling the power line as an antenna system for 187 meters and you'll get the idea.

The usual method for tracking down power line noise is to use radio direction finding techniques at the higher frequencies. In fact, we'll use the highest frequency that we can hear the noise on. This is a bit counterintuitive, in that the noise may be killing us on 40 meters but we'll use 2 meters or 70 cm to track it down. This is possible because the power-line sparking is inherently a broadband noise source. At the higher frequencies, we can pinpoint the noise source using a reasonable size directional antenna.

Tracking with VHF / UHF

There are commercially-made antenna/receiver combinations available for tracking power line noise, but you may already have the basic equipment for tracking down the noise. A common method is to use a portable VHF receiver and a small Yagi antenna. Since we are chasing a broadband noise source, this does not have to be on any particular frequency. It is helpful to be able to adjust the receiver frequency to avoid other signals that might be on the band. It also helps to check a range of frequencies to confirm that the noise really is broadband.

One good choice for a receiver is a portable HF-through-440 MHz QRP rig, the Yaesu FT-817 (Figure 2). We'll use it in AM receive mode, as we are trying to capture sparks which are amplitude pulses. With the FT-817, we'll be able to flip across the HF bands and listen for power line noise as well as use the VHF/UHF bands to zero in on the source.

You can also use a handheld VHF transceiver, as long as it has AM receive and an S-meter. Some of the older models only receive FM, which is not useful. The noise-rejecting ability of FM gets in the way of tracking this sparking signal. It seems that most of the newer HTs offer AM receive, enabling the ability to listen to the aircraft band. Some of the HTs have a wideband receive function, spanning HF through UHF frequencies, which is also useful.

Another radio receiver option is a handheld police/fire scanner. Again, it must have the ability to receive amplitude modulated signals. Scanners are often lacking an S-meter, which is really important for obtaining relative signal strength

as you are moving around.

For an antenna, a small Yagi for 144 MHz and/or 430 MHz is effective for tracking down the noise. I use my hand-held dual-band Arrow II antenna, which covers both bands (Figure 3). Typically, I'll hear the noise on an AM broadcast receiver or the FT-817 listening on HF. If I am close enough to the noise source, I can switch over to 144 MHz and hear it there. Now I get some directional capability and pointing to and away from a suspected pole narrows down the potential noise source. As in all directional finding work, it is easy to get confused by multiple noise sources and reflections. Checking a particular pole from multiple directions helps. If you are close enough to the source, you'll probably hear it on 430 MHz, too. This provides even tighter directionality which should give you higher confidence in the location of the source.

Keep in mind that there are lots of sources of RF out there. You might find yourself tracking down a signal that is not coming from the power line. Even more confusing, the signal might be present on the power line but it might originate inside someone's residence. It is common for RF to couple onto the power line and take a ride down the street.

Figure 3—A dualband yagi antenna for 144 MHz and 430 MHz, pointed at a power pole.

Safety First

When it comes to working around power lines, safety must come first. This is really just common sense: Keep yourself and all objects away from the power lines. They are dangerous and they are the property of the power company.

It is not your role to fix the problem, only help identify it to assist the power company in fixing it. Per FCC rules, it is clearly the power company's responsibility to remedy radiated interference. You can help by pointing them in the right direction by sharing what you find. But don't get into the business of trying to fix it yourself.

At some point, you'll need to contact the power company. The ARRL has some guidance on its web page on how to do this. If you can't get the power company to react, you'll have to escalate the issue. (Again, the ARRL website is a good resource.)

More Information Available

This is really just a brief introduction to tracking down power line noise, with an emphasis on using your VHF/UHF radio gear. This is just another use for your VHF equipment and it may be a critical help for your HF operating, too.

I found two really good sources of information on dealing with power line noise: the book by Marv Loftness, KB7KK and the ARRL web page. Both of these are listed as references below. I highly recommend that you do additional study to understand the finer points of tracking down power line noise.

—72, Bob KØNR

References

1. *AC Power Interference Handbook,* Third Edition by Marv Loftness KB7KK, 2007. Available from the ARRL bookstore.

2. "The Power-Line Noise FAQ Page", ARRL web site: http://www.arrl.org/tis/info/powerline-FAQ.html.

A QRP SSB TRX for 6 Meters, Part I

Allison Parent—KB1GMX kb1gmx@arrl.net

Every so often I start a receiver, transmitter or transceiver because I happened on a design, or a fragment of one, that might apply well or offer a different approach. This transceiver is one such example. I happened to look at Epiphyte and Lichen style radios and wanted to see if I could arrive at a low power design that might be suitable for a favorite pastime of 6-meter hilltopping.

Here's a little bit about how I came to this particular radio approach. Back a few years, my first 6-meter radio started with a case from a SSB 11-meter CB that was nice, but the electronics were junk save for the crystal filter and carrier oscillator crystals. I built a radio around those parts, and wound up with a 5 W output transceiver that I have and still use. However, it has a few characteristics I don't like. It's heavy at more than 8 pounds for the radio alone, due to the nice strong steel case. While it's evolved into a very good radio, it also uses a lot of power at nearly 400 mA on receive with the volume down and much more with it up due to a 7 W audio output. On transmit, the radio requires more than 2 A. That drain makes for limited operating time on 7AH, 10 V sealed lead acid batteries. So I wanted a smaller, lighter transceiver and, most importantly, lower power consumption. And, I was not willing to give up general performance either.

Why 6 meters? It's my favorite band. Hardly an answer, but actually there's much more at work. Six, the magic band, was my first real challenge since getting my ticket as a Technician class licensee. It's the only band in the VHF range that has worldwide coverage without EME. Now, Techs are allowed a sliver of 10 meters for phone too. But 6 meters is more than that, as a 6-meter beam is home buildable and, most important, small enough that it's more easily accomplished for the experimenter. This allows an operator on 6 meters a shot at making contacts with less power and still being heard. To make a point, a 6 meter, 3-element beam does an easy 7 dB of gain, has a longest element around 117 inches, a boom of 6 feet, and commercial versions can weight as little as three pounds. That 7 dB means a multiplier of 5 over a dipole for the power you put in. Also, at 6 meters, an antenna 18-20 feet up performs as well as an HF tribander at 60 feet! That may seem a simplification but antennas start to perform when they are high in terms of wavelength. Sixty feet is desirable for many of the HF bands, but 18 feet is far more manageable when portable. This means a QRP operator can have an antenna that can make low power work like more.

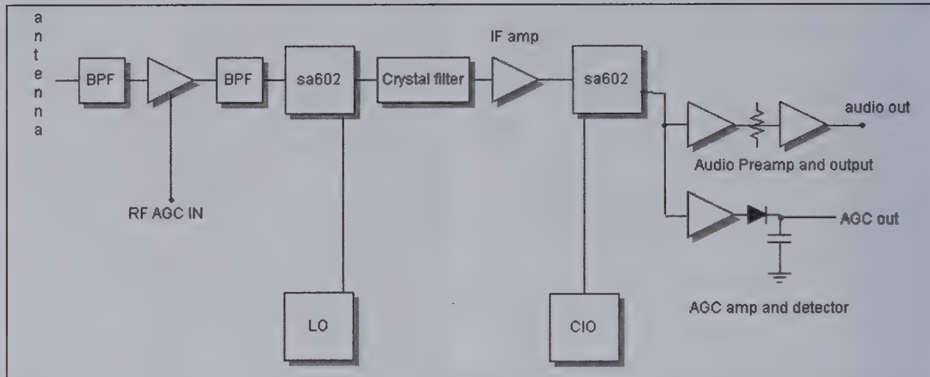


Figure 1—6 meter SSB receiver block diagram.

Right now, 6 meters is fairly quiet as we are in the bottom of the sunspot cycle, but every Spring and at random times we get sporadic-E propagation and the band wakes up with 500-1,500 mile contacts. If that wasn't enough, in another few years with more spots on the sun, long distance contacts will become more commonplace.

That's only half the picture. Building at 6 meters is easier because finding parts that work at 50 MHz is easier than finding parts that work at 144 MHz and above. While it's VHF, it's not as finicky about ultra short leads as the higher 2 meters-and-up bands. Building at 6 meters is very similar to building at 10 meters. Remember that 8-pound radio I mentioned earlier? That was my first radio on 6 meters in 2001, and it has 14 countries and many states to it's credit using a two element beam at 5 W. So it's valuable to recognize that low power and VHF doesn't mean local contacts only.

System Overview

This section is a coarse overview, and it assumes some knowledge of superhet receiver design and SSB generation via the filter method. From a design standpoint, this receiver is limited in its overload capability (approx. –25 dBm input IP), which is not terrible, but the trade off was a stiffer mixer used with 10-40 times the power consumed. The result was a dynamic range of about 70 dBm, which is only fair for VHF radios. At lower frequencies, the RF gain used should be lower and this would help the overload point greatly. I opted for higher gain at 6 meters as I do weak signal work. However, with a step attenuator this is not a handicap as it saves using gain at IF, provides an AGC point with good overload characteristics, and it's simple.

I started with a simple description of what I wanted, which I will now translate to a list of design goals:

- USB SSB
- Low power drain, especially during RX (under 120 mA including PLL module!)
- Low parts count, simple construction
- Simple T/R switching, relays are as simple as can be.
- Transceive reusing same RF/IF path
- Sensitive receiver
- Selective receiver (better than the usual 4-crystal filter)
- Single conversion receiver and transmitter with high IF.
- Transmitter power in the 1 W (RMS) range.
- Nominal 12 V power source (small gel cell).

Note that the local oscillator is not discussed in the list of design goals. That's because it is a separately developed, sampling/tracking PLL circuit. Here it will be treated as a module that provides the need-

ed LO at the correct frequency and power levels to drive a SA602. The oscillator I used draws about 40 mA from the 120 mA budget. What's important for your LO is that it be a clean source that can cover, in this case, 42 MHz to 42.3 MHz which corresponds to the 50.000 to 50.300 MHz weak signal segment of the 6 meter band.

So that is the basic idea. The design is based on many sources and inspired by several designs that reuse stages. It is also based on a desire to build from the junkbox, rather than an exotic parts catalog. Using "unobtainium" was a non-goal. Some choices, like using relays, seem odd. As some would say, electronic switching using diodes or other parts is easier. However, even diode switches require continuous power to assure their switched state, and when you use a bunch of them it adds up and can hurt power drain on receive. Small relays are easier to understand and can be placed conveniently. Plus, they only require power when active, such as when transmitting. Other choices, like 1 W (milligallon), are compromises to allow power savings and using cheap RF transistors. Besides, with a good antenna on a hill, 1 W does well on 6 meters. Lastly, simplicity was a "just because" thing.

How did I arrive at the design? Well I could list a lot of highly technical reasons and all that, but mostly it was a whim. I'd built four other 6-meter transceivers using various design topologies and used them, noting their good points and weaknesses. It is about exploration and experimentation. I try things to see if, in real world use, does it work, fail or what. Experience is a good teacher. Something that is different always catches my curiosity as well.

So, I went back to the basic block diagrams for SSB receivers and SSB transmitters. You need a place to start and that works for me. Figure 1 is the usual single conversion SSB/CW receiver layout. The line up includes an RF amplifier, mixer, filter, some IF gain, and a product detector followed by an audio amp. Figure 2 is a standard SSB transmitter using the filter approach. Again, we see a modulator, otherwise known as a balanced mixer, a crystal filter, some IF gain, a mixer to arrive at the TX frequency and a power amplifier chain. At this point I've not mentioned bandpass and low pass filters needed to avoid unwanted signals. But this is a very common textbook SSB radio design and EMRFD [1] covers those points really well.

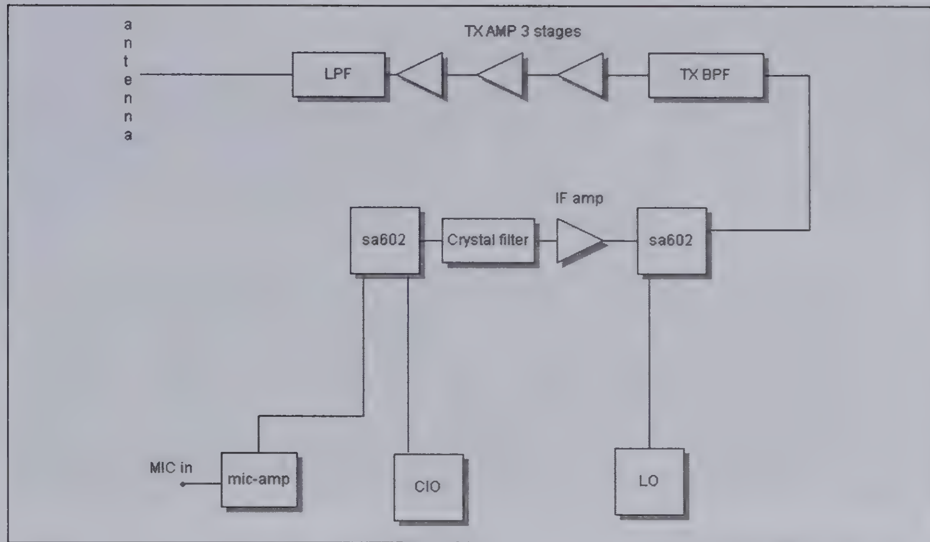


Figure 2—SSB transmitter block diagram.

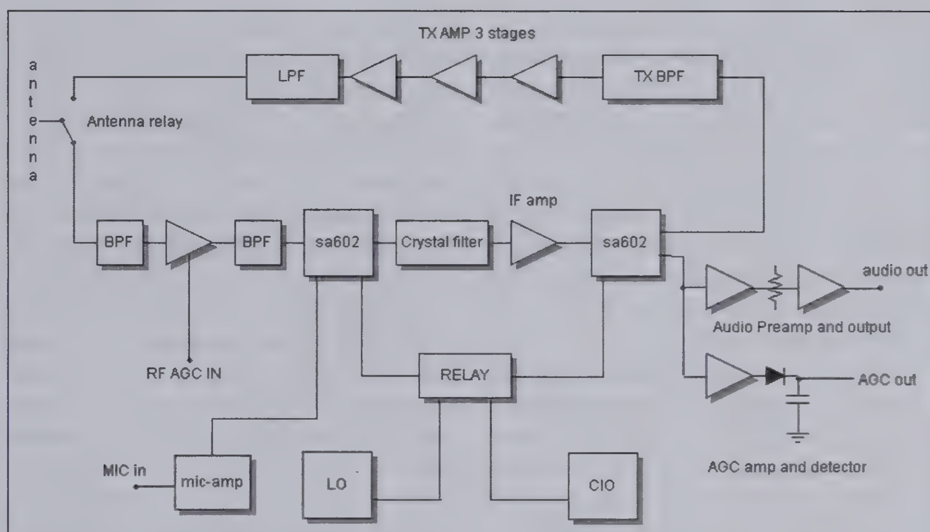


Figure 3—Transceiver block diagram.

The goal however was a transceiver, so we arrive at Figure 3. Why design a transceiver that reuses common sections? The usual answer is cost, sometimes parts availability. In this case, power consumption was a factor in the decision process. What makes this figure interesting is that the two mixers, the crystal filter, and the IF are used for both TX and RX. Further, the signals always progress from the microphone or antenna to their respective outputs without switching. How is that done? By taking advantage of a near-universal RF part, the SA602 Gilbert cell mixer. This mixer has a balanced input and a balanced output for RF, and a single ended input for the local oscillator. Since that balanced capability means two inputs and two outputs for practical cases, we take advantage of it. That duplication means we can make the part do two things when we need to do so. For example on receive, one input can be from the bandpass filter that is on the receiving RF amplifier output. So, we can mix the 50 MHz input down to 8 MHz with a 42 MHz local oscillator to feed the crystal filter and IF amplifier. On transmit, the other input can accept microphone audio, and the oscillator input can now be 7.997 MHz to give an 8 MHz DSB signal to the crystal filter. We just made a part do two similar functions. The crystal filter and IF amplifier never change their function, and are there for both receiving and transmitting functions. The next SA602 mixer is asked to take that 8 MHz signal and operate as a product detector on receive

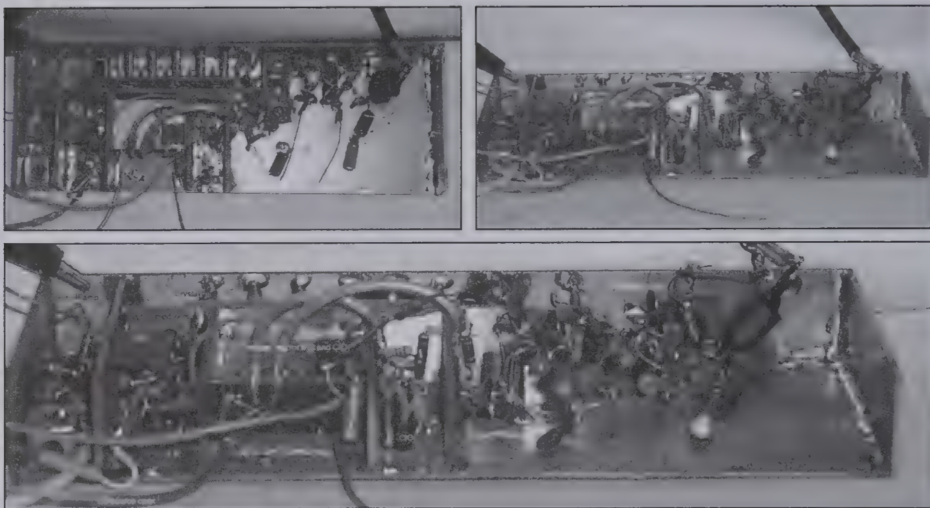


Figure 4—Several views of the 6-meter transceiver.

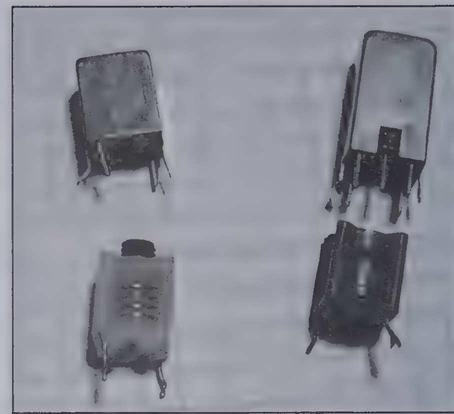


Figure 5—Coils used in the 6-meter transceiver.

using the 7.997 MHz carrier oscillator. Or, we can make it deliver 50MHz when transmitting by injecting a 42 MHz local oscillator instead. Since the part has two outputs, we can route audio off one output to the receiver audio or, using the other output, send it to a 50 MHz bandpass filter and RF power chain with no switching other than where two oscillator outputs go.

Construction Notes

With the above points covered, we can talk about construction. There is no PC board. I never gave that idea a thought. I built this transceiver using ugly construction because short leads are easy, ground is ground everywhere, and shielding is easy to construct and add. This construction method assembles fast and changes are easy to implement. Which brings up a point, Figure 4 shows how I built the radio. Its layout closely approximates the block diagram. Its inputs are at one end and the outputs are on the other just like the signal flows.

Since this is a fairly small transceiver at 7 by 2.5 inches, its compact construction would not be possible without shields to keep the closely spaced electronics from talking among themselves. To allow interaction would likely make this transceiver into a fancy oscillator, or worse a source of many spurious signals. The whole transceiver is made of single sided G10 1/16 inch thick printed circuit board material. Some areas where shielding can have a big influence is around high performance filters, be they crystal or coils and capacitors. Shielding is important here as it keeps the undesired signal from finding a way around the filter and degrading its performance. Speaking of filter I used shielded coils from an assortment gotten years ago from Radio Shack. A few or the coils are shown in Figure 5. The 7/16 inch shielded forms were very handy for the input to the RF amp and the double and triple tuned filters at 50 MHz. They are not as compact as some coils, but handy and well shielded. And, owing to the tinned can, easy to solder down to the PC board for mounting. While these particular coils may not be available from current stock, there are many suppliers of suitable adjustable coils that are similar and have the same inductance.

So there is an approach and a block diagram. Some of the schematics will be in this part of the article as well, but only the core of the transceiver for this issue.

General Circuit Description

The intent of this design is a complete and reasonably simple transceiver, using a limited number of parts in the RF path, and reusing most of those parts that are core to superhet receive and SSB generation. I wanted a transceiver that can hear weak signals and makes no compromises on transmitted signal quality. As noted previously, the basic design relies on the handy SA602/612 mixer. The part uses very little power, provides multiple outputs and inputs that we will exploit and has a decent amount of gain. As always, it is a work in process. Even some of my "finished radios" see changes as I see fit. Figure 6 shows the receiving RF amplifier and the first common mixer.

For this radio, I reused an old design for the receiving RF amplifier that I'd stumbled on many years ago and found useful. The design uses a JFET and BJT in a cascode circuit, both for gain and to provide a point for receive AGC. The AGC range for this circuit measured greater than 50 dB, enough for my use. What is unique here is that the AGC is applied to the base of the BJT and swings from about 2/3 of Vcc to ground. This amplifier drives a double tuned bandpass filter to cover the 50.0 to 50.3 MHz range. A triple tuned filter would have been better, but for portable operation without strong TV stations this works. The filter is needed to avoid overload from close by TV stations, and it helps with setting the noise performance of the receiver. This stage is only used for RX and is power switched. Measured sensitivity for this receiver is MDS of –139 dBm and it's quiet with good AGC performance. Power drain for this amplifier runs at 9 mA at maximum gain.

The receive mixer and transmit balanced modulator function are accomplished using a single SA602/612, as discussed previously. This IC is unique in that there are effectively two inputs and two outputs as a result of the differential design. As a result, it is relatively easy to make this IC perform two functions. And, as a bonus, current drain is quite low for the SA602/612. But, like all things, the use of a SA602/612 has a down side. In this case, the downside is the limited dynamic range mentioned previously. If a more overload resistant receiver was desired a diode DBM with a high IP output amp and LO injection amp and diplexers would fill the bill at many milliamps per stage. Analog Devices also makes a high level (AD831) mixer that compares to a diode DBM, but it also wants 80-110 mA for the same results.

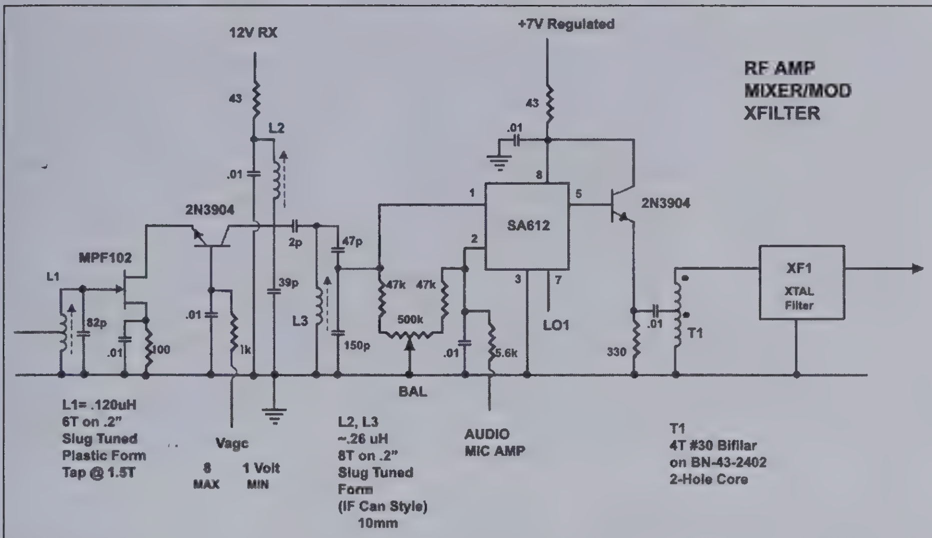


Figure 6—Receiving RF amplifier and first mixer.

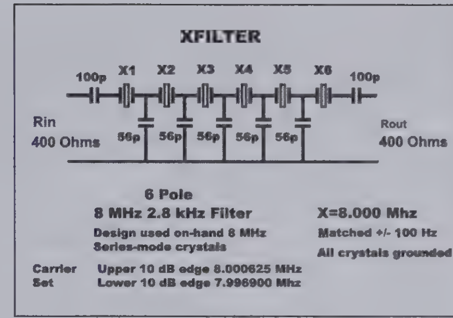


Figure 7—The IF crystal filter.

In either case the power for a pair of lowly SA602s is a mere 8 mA compared to 100 mA or more for other higher performance parts. Since battery operation is desired this is possibly more important than a high resistance to overload. I do not view the SA602 as weak. It is a low power device and does exceptionally well for that total power level. One note on the SA602/612 is that operation close to 7.5 V (8 V max) voltage does help in the overload specs by easily 3 dB over operation at 6 V.

The output of the 50 MHz filter feeds one input of the SA602 mixer (there are two) on receive. When transmitting, the other mixer input will have amplified microphone audio applied to use it as the balanced modulator. The input has a balance potentiometer, added to improve the transmitted carrier nulling. At this point, I need to point out that during receiving, the mixer will be driven with 42 MHz local oscillator to drive the 8 MHz IF and during transmitting that oscillator will be replaced via relay with the 7.997 MHz carrier oscillator for USB (using low side LO). The output of the SA602 drives an emitter follower transistor to match the high 1500 ohm mixer output impedance to the lower 250 ohm input of the filter. This also provides a bit of power gain along the way.

The crystal filter shown in Figure 7 is used for both receiving and transmitting, and was developed separately. A filter from other sources could have been used, but I wanted to experiment. I used six 8 MHz microprocessor clock crystals, selected for frequency by using a simple oscillator circuit and frequency counter. They were selected for less than 80 Hz variation (6 out of 12 purchased were in the same vendor same lot number). These crystals, with 100 pF capacitors, resulted in a 2.3 kHz bandwidth at –6 dB gain and about 4.5 kHz bandwidth at –60 dB gain with respect to the gain at the center of the passband. This performance is substantially better than similar filters using only four crystals. The other significant point is that ladder filters have a softer slope on the lower frequency edge, and more crystals improve this slope enough to make an acceptable USB filter. Terminating loads for these filters are important to good results, so a JFET IF amplifier is used to terminate the filter and also compensate for losses through the filter.

Another SA602/612 is now used to both provide product detection on receive and transmitting mixer service. See Figure 8, which also shows the JFET IF amplifier. This is done by taking the recovered audio off pin 4 on one side of the mixer output and RF off pin 5. The oscillator input is switched between the carrier oscillator on receive and 42 MHz LO on transmit. The only care required here is matching the impedances and filtering out the required signals. For the audio path, a passive low pass filter is adequate for SSB. An amplifier follows the RX audio, gain control and speaker amp. The audio path also has an audio derived AGC amplifier and detector of simple design. For the transmitting RF path, a triple-tuned band pass filter, centered at 50.15 MHz (nominal), is used.

[This article will continue in the next issue of *QRP Quarterly*.]

References

1. Hayward, W., et al. *Experimental Methods in RF Design,* American Radio Relay League, Inc. 2003.

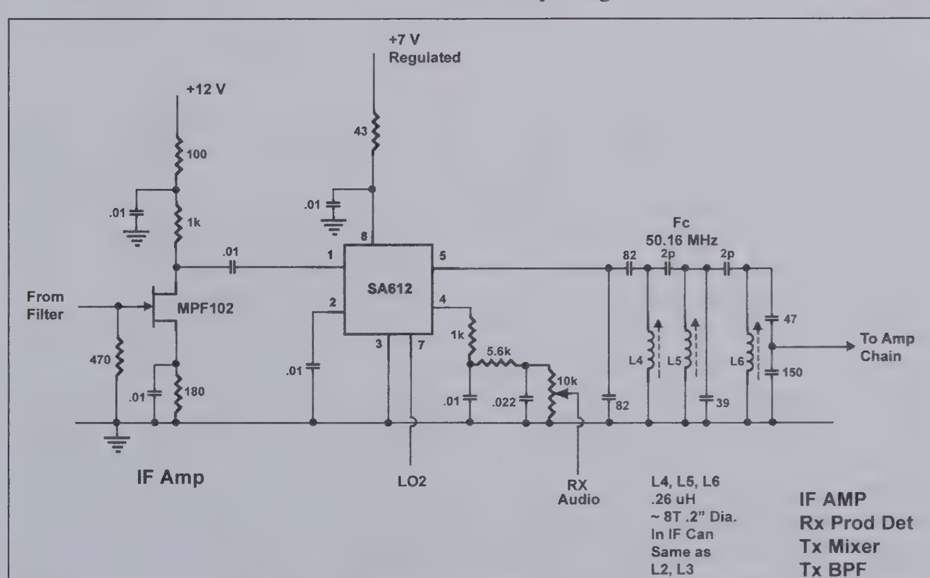


Figure 8—JFET IF amplifier and second mixer.

Ten Little Rockmites

B. Scott Anderson—NE1RD

ne1rd@arrl.net

Interested in injecting some energy into your local radio club? Try sponsoring a kit building adventure! PART, the radio club of Westford, Massachusetts held a kit building event on 23 February 2008. The club-sponsored kit was the Small Wonder Labs RockMite, a single board 40 meter transceiver, an ideal kit for the first time builder.

Kit builders were offered a package including the RockMite kit, including all controls, from Small Wonder Labs, a pre-drilled aluminum enclosure prepared specially for the event, an 8-watt dummy load kit, and a grab bag of handy parts any QRP enthusiast might need including BNC-SO239 adapter, BNC-BNC patch cable, 1-watt dummy load, molded power cable with barrel connector for the radio, and a 49 page assembly manual with step-by-step instructions. The price for this package (including meals, drinks, and snacks for the day) was $75. Those wishing to take the road less traveled were encouraged to bring their own kit and pay a modest "participation fee."

Figure 1—Our Group: Front row (L-R): Scott Wood (No call yet), Alan (KD1D), Rick (W1RAG), Allison (KB1GMX); Middle row (L-R): Alan (K1ALL), Bob (N1RXV), Andy (KB1OIQ) and daughter Kimberly (KB1PZG), Rich (AB1HD), Steve (WA1KBE); Back row (L-R): Hugh (N1QGE), Tom (K1NNJ), Randy (KB1NTF).

The event was hosted at the Westford Methodist Church in a very large meeting area. Tables were set up by 9 AM and builders were given their kits, manual, and parts. After a brief introduction by event co-chairs, me (NE1RD) and Rich (AB1HD), a hush fell over the room as builder put their heads down and began soldering.

Many of the ten participants were either first time kit builders or hams that had done very little electronics work. Several experienced club members provided "Elmering" services to those most in need of it. The "build" event quickly became a "team building" event. Even those builders who were not having any troubles would periodically stop and show their work to other club members to seek feedback. When the assessment came back, "Looks great!" it would invariably boost the confidence of the builder encouraging him, or her, to soldier on.

There were some builders who had never soldered before. They wondered aloud as the event began if there was something they could "practice on" before starting their RockMite kit. Indeed there was! The 8-watt dummy load kit was included in the bundle for just this purpose. Several Elmers sat with new builders as they constructed their dummy load kits. The entire kit consisted of only a single small circuit board, four 200-ohm 2-watt resistors, and a BNC molded cable with a bare wire end. Assembly was a snap and a quick check with an ohm meter showed the requisite 50 ohms. Though this was a very small and simple kit to assemble, it was a significant confidence booster for those new to soldering. I would recommend a small "practice kit" for any event of this kind.

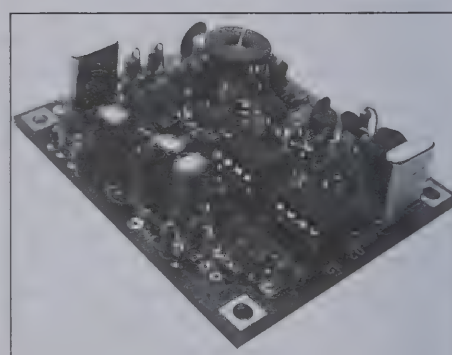


Figure 2—The RockMite, the object of our desire (courtesy Small Wonder Labs).

As the day progressed builders began completing their radios. The circuit boards were completed first. Then, one-by-one, the radios were mounted into their enclosures and wired to the jacks and controls. One of the club's most experienced builders Allison (KB1GMX—also a contributor to *QRP Quarterly*) completed her radio first. A round of applauds erupted as the beep beep from the amplified speakers echoed around the room. Allison then connected a short wire to her dummy load and her radio became the official receiver for subsequent tests. As others finished their work the radios were taken to my test station, put on a dummy load and QRP power meter, and put through their paces. Each radio, in turn, was tested as both receiver and transmitter.

When five PM rolled around there was a short line of those who had just finished

Figure 3—Kimberly (KB1PZG) helps her father, Andy (KB1OIQ), sort capacitors for the RockMite.

Figure 4—Three of our hardworking builders, assembling and soldering carefully.

looking for help with the final test. Each successful test resulted in a hearty congratulations and round of applause. In the end, seven of the ten radios were completed and tested during the event, two other radios were completed and tested by the end of the weekend, and one radio (belonging to a first-time builder) still needs a little help to get over the finish line. The Elmers in the club will make sure that little lost sheep also finds its way. This level of success was a little startling even to the organizers. Nine of ten kits worked immediately. Well done, group!

Flush with success from this adventure there are already discussions of having another building event later this year. Interestingly, it wasn't clear who had more fun: Elmers or builders! If you are looking for a ways to bring a little life to your local radio club this is an activity worthy of consideration.

Special thanks go to Dave Benson of Small Wonder Labs for getting our very late order of 10 kits shipped to us in plenty of time for this event.

PART of Westford, MA was established in the mid-1970's and has been serving Eastern Massachusetts continuously for over 30 years. PART's home on the web may be found at http://www.wb1gof.org

B. Scott Andersen (NE1RD) is an avid builder, QRPer, and has a love of lightweight DXpeditioning. First licensed in 2002 he has been busily trying to make up for lost time. His web site is http://www.bsandersen.com

QRP Contest Logging Software

Bob Patten—N4BP n4bp@arrl.net

I was asked to review logging software for the QRP ARCI contests. I've chosen to review CT, NA, and N1MM Logger for three reasons:

1. I'm quite familiar with theseprograms, having used them for some time.
2. They fully support the QRP ARCI, MI QRP, and SOC contests.
3. They are free!

CT is the grand daddy of them all. In checking what logs I could find, my first efforts with CT computer logging date back to 1993, fifteen years ago. But when CT was introduced by Ken Wolff even earlier, it supported mainly DX contests such as those sponsored by ARRL and CQ. Soon after, NA was introduced by Dave and Tom Pruett to cover the domestic contests. Both have since evolved to cover both domestic and DX. Since they are so similar, and I abandoned CT many years ago, I'll concentrate on NA. The major difference is that CT was more recently developed to also run under Windows while NA was not. Most other features listed for NA also apply to CT. CT is available as freeware from: http://www.k1ea.com/.

NA became my logger of choice also in 1993, although its introduction to ham radio may have been earlier. It is still a DOS application and will run on the simplest of computers (I've run fairly recent versions on a Poqet using an 8088 CPU, although that setup is too slow to also use super check partial). It will also run under Windows, although its CW output can become erratic. Its main utility of course is to log contest QSOs, although it incorporates many other features to assist in the process. While logging it will indicate if a station has been worked before on the band you are on (dupe QSO) and at the same time show QSOs for any other bands on which that station has been logged. As soon as the SPC is keyed in, it will tell if the SPC is a needed multiplier and, in addition, keep a running account of your score. To assist in copying calls correctly, it utilizes "Super Check Partial" or "SCP" (more on SCP later).

NA incorporates a fully functional software keyer, requiring a simple interface between either a serial or parallel port and the transceiver's keyed line. Details for the interface may be seen on the DaTom website, http://www.datomonline.com/. You may also connect your paddle to the same computer port and manually send CW. But

the beauty of its software keyer is that you can pre-program up to seven function keys to send repetitive messages (CQ, Exchange, Your Call, etc.) and it will even accept special characters such as "@" to send the other stations call. It's possible to complete most QSO exchanges without ever reaching for the paddle! The speed of the software keyer is adjustable from the keyboard.

NA includes computer control of most commercial transceivers that can use it. With computer control, you are assured that your radio and logger are on the same band (very important - and easy to slip up on without it!). You can easily set the band, frequency, and mode of your radio from the computer keyboard.

When a contest is ended, NA can output several different files for you. Most important is the Cabrillo file which is now required by most contest sponsors. ARRL, CQ, and others have the software to easily crosscheck Cabrillo logs and can calculate very accurate results. ARCI and many others have not yet migrated to the Cabrillo format, and for those a "PRN" file can be generated for the log and a summary sheet also provided for your reported results.

There are many other features included in NA, but these are best explored when running the application. At present, NA can be downloaded free from: http://www.datomonline.com/, although no announcement has been made that it is to remain freeware.

N1MM Logger is a Windows based logger which will run on anything from Win95 to Vista. It is a little more difficult to set up and has a higher learning curve - but is well worth the effort! It will do everything that NA will (except for accepting paddle input - you will need a separate keyer for manually sent CW) plus MUCH more. To fully enjoy the added benefits of N1MM, you will require an internet connection. Then, you will have access to Telnet. With Telnet, you can populate the bandmap with calls that have been "spotted" by other users and click on those calls to instantly send your radio to their frequencies. The calls in the bandmap will be highlighted in red if they are needed multipliers, in blue if they are needed stations, and in grey if worked before. You can also spot stations yourself by simply clicking on "spot." After typing a call in the callsign box, clicking on "Buck" will bring up your default internet browser, go to the QRZ.com website, and look up the call you typed. This is a convenient way to check if you have copied the station's info (mainly SPC) correctly. Once the QRZ website has been loaded the first time, subsequent callsign searches are very quick.

N1MM also has the ability to send pre-programmed CW messages via the function keys. But, in addition, it has a built-in DVK (Digital Voice Keyer) allowing you to send pre-programmed voice messages via the function keys. The messages are recorded as Windows .WAV files and the function keys are linked to the appropriate files in the configuration. If you want to take the time, you can also voice record all of the alpha-numeric characters (a-z, 0-9) and use them to "say" the call of the station you type into the logger. Similar to CW, when everything goes properly, you seldom need to even reach for the mic! There are many more features available in N1MM, but the website explains them better than I could. N1MM can be downloaded free from: http://www.n1mm.com/

A few words are in order about Super Check Partial for those not familiar with the concept (all three of the reviewed loggers make use of SCP). Master data files are created from logs gathered from many operators in many contests. K5ZD is presently collecting the logs and creating data files for domestic and DX contests as well as contests that allow QSOs in both categories (such as the ARCI QSO Parties). When SCP is active in the logger, typing in the first few letters that you copy will create a list of calls that it "could" be. For example, if you type in "VA3J," the displayed list will tell you that the full call "could be" VA3JFF, VA3JFF/W1, VA3JNO, or VA3JSL. Knowing that VA3JFF is our present contest manager, chances are the next two letters will be "FF."

If you missed the prefix and copied "JFF,", SCP will list N9JFF, VA3JFF, and W7JFF. You already have a pretty good clue which one it likely is. And, if you copied the SPC as "ON," you have no doubt. A very useful tool, but not to be overly relied on as it also has its pitfalls. More information about SCP and free updated files are available from: http://k5zd.contesting.com/scp/

All three loggers also use "country files." These are used to correctly identify countries heard and worked by the prefix in their call letters. There are several files available, so you need to know that "CTY.DAT" is used for CT, "COUNTRY.DAT" is used for NA, and "WL_CTY.DAT" is used for N1MM. Country files are updated periodically by AD1C and can be downloaded from: http://www.country-files.com/

I still remember the days of paper logging and huge dupe sheets. It is really remarkable how much easier logging software makes the whole process from the first QSO to submission of the entry. Within minutes of a contest's completion, the entry can be e-mailed to the sponsor and your work is done. In the "good old days," sometimes hours of work were required to prepare the log and summary for submission, and then a stack of papers had to be snail mailed to the sponsor. The tools available in the loggers certainly add to the fun of operating. I particularly enjoy watching the QSO count, multipliers, and score increase while operating. And instead of searching that huge paper dupe sheet when you hear a call, now you are instantly informed if the station was worked before. The list of advantages over paper logging goes on and on. If you've never tried logging with your computer, you really should give it a go. Best of all, the software is free!

Antennas 101: Measurements Through Coax

Gary Breed—K9AY

k9ay@k9ay.com

When your antenna is at the top of a tower or strung between tall trees, it can be very hard to put your antenna analyzer or R-X bridge right at the feedpoint! So, it's important to understand what happens when you make a measurement at the end of a length of coax:

1) SWR is the same everywhere along the line—If your objective is simply to prune the antenna to lowest SWR at your favorite frequency, no special effort is needed to correct for the coax length. If the SWR bridge is properly calibrated for 50 ohms, the length of your RG-8, RG-58 or RG-8x doesn't matter. Quite often, you will see a change in SWR with different lengths of coax, but this is usually due to the calibration of the bridge, although it could also be due to RF on the outer conductor disturbing the measurement. As long as the change is not large, you will be OK. Your radio does not need an exact 1:1 SWR, and feedline losses don't increase much until the SWR gets quite high.

2) The transmission line transforms the impedance—If you want to be more precise and determine the impedance at the antenna terminals, it is possible to "subtract" the effect of the coax. Let's say you have a 2-element wire beam for 20 meters and you want to adjust the beta match inductor and prune the driven element length to get exactly 50 ±j0 ohms. Like a good experimenter, you first installed the antenna at a low height so you could do a preliminary adjustment on a stepladder or rooftop. But when raised to its final height of 50 feet, the SWR at the bottom end of a 65-foot RG-8x feedline increased to 1.4:1 and you measured an impedance of 54 –j18 ohms with an R-X bridge. At this point, you might think, "All I need to do is lengthen the element a little to cancel that 18 ohms capacitive reactance." ...but you would be wrong! 65 feet of coax is about 1-1/8 wavelengths at 20 meters, and it has "rotated" the actual impedance of the antenna along its length.

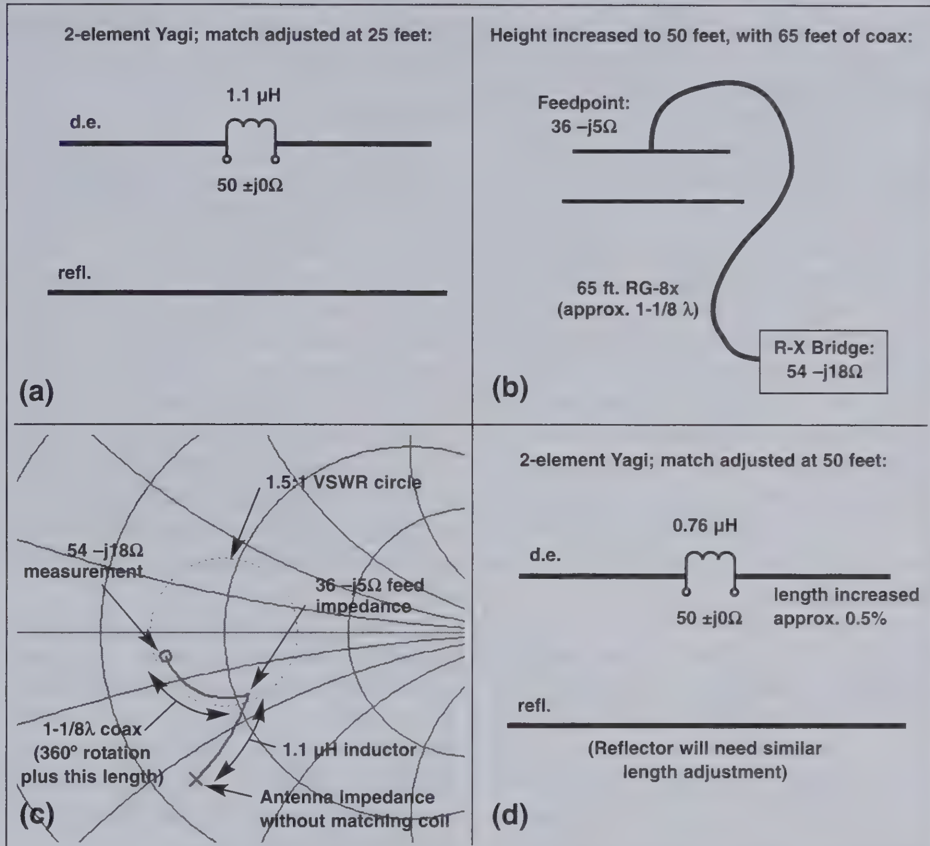


Figure 1—(a) Example antenna at 25 feet; (b) Antenna raised to 50 feet, with 65 feet of coax; (c) Smith chart illustration of measurement; (d) Final antenna adjustments.

Figure 1 shows this scenario. Fig. 1(a) is the 2-element beam at 25 feet, where the first adjustments were made. A 1.1 µH inductor across the feedpoint and pruning of the driven element length gave you a good 50 ohm match. Fig. 1(b) is the same antenna raised to 50 feet, with the coax attached. The impedance at the far end of the coax is 54 –j18 ohms, but at the antenna it is actually 36 –j5 ohms. The Smith chart plot of Fig. 1(c) is a bit complicated, but shows how the feedline changes the impedance. This plot also confirms that SWR remains constant along the transmission line; it just changes R and X values.

Antenna books tell you that increasing the height of an antenna increases its resonant frequency, requiring slightly longer elements. This is confirmed by the shift toward capactive reactance. Also, you have read that the impedance swings up and down as height is increased, with as much as 2:1 change. In this case, the impedance has become a bit lower, requiring a smaller matching inductor to make the transformation to 50 ohms.

Fig. 1(d) is the antenna after final adjustments. The driven element has been lengthened a bit to lower the frequency, and the inductor was decreased almost by half to 0.76 µH. With an accurate match to 50 ohms, there is no excess feedline loss and the antenna will work as expected.

This illustration used a Yagi, which also must consider the required change in reflector versus height. In general, it will be the same percentage change as the driven element, but this should be confirmed with accurate modeling and perhaps additional measurements. This is beyond the scope of this article, but I wanted to be sure it was noted.

I used a Smith chart to see the effects of the coax length, but there are also several computer programs for hams that will calculate impedance changes through coax—such as the disk accompanying the *ARRL Antenna Book* and software by G4FGQ (SK). There are various Smith chart programs, as well. Check out: www.rfcafe.com/references/electrical/smith.htm.

The ABR-1 Multiband CW-SSB Transceiver

Jeff Hecht—K8GD
k8gd@dslextreme.com

[Editor's Note: Jeff is a new author for QRP Quarterly, *but as you can see he is already an accomplished builder. His article concerns his entry into the FDIM Buildathon in 2007. Since its inception, FDIM has sponsored various building contests. Each year there have been two general categories—one for all home brew and one for a modified kit. There were twelve total entries in 2007, nine of which were in the home brew category. A team of three judges looked at the home brew entries to determine first, second and third place. Judges used a mixture of criteria such as overall circuit design, quality of construction and layout of controls. Last year, K8GD's ABR-1 design, shown on our front cover, won first place in the home brew category.]*

My beginning into "home brewing" equipment started when I discovered the 2N2/40 design by Jim Kortge, K8IQY. As is common with many builders, the desire to operate with a piece of equipment constructed at home was a goal I wanted to achieve. I successfully worked my way through college studying for a degree in Electrical Engineering by working for a local consumer electronics repair shop. Through this employment, I gained the much-needed experience working with printed circuit boards, soldering, and other requisite skills required to achieve my goal. Not being satisfied with building a kit, I wanted to construct something from scratch and the 2N2/40 fit the bill nicely. Subsequently, I built a Norcal 20, a 2N2/30 and a 2N2/20, all using the Manhattan construction technique. Needless to say, I was hooked.

While attending the QRP ARCI FDIM in 2006, I was able to study the I/Q Pro VFO designed by Craig Johnson, AAØZZ, for direct conversion applications. I was able to speak to him at length about the design using the Analog Devices AD9854 12 bit DDS generator and the PIC controllers used. I reasoned that a variation of this VFO design could be used in a single conversion multi-band transceiver. It was here that the ABR-1 idea was born. I also challenged myself to incorporate SSB capabilities into the design along with the traditional CW mode common to many homebrew transceivers.

Overall Design

Many of the stages used in the ABR-1 are based on previously published designs, with adaptations needed for multi-band and multi-mode operation. Much of the design was prototyped on the computer using Linear Technologies LTSpice Spice simulator, with the crystal filter designs done primarily using AADE Filter Design and Analysis. Many of the SSB ideas I gleaned from the five part *QST* article "The Principals and Building of SSB Gear" by Doug DeMaw, W1FB published in 1985. Without the published works of others, the ABR-1 would not have become a reality.

Figure 1 shows a block diagram of the transceiver. The design is that of a filter-type SSB/CW transceiver with an IF of 4.915 MHz, a frequency chosen in part because of the availability of inexpensive crystals for filtering. A detailed schematic is available from the author via e-mail at k8gd@dslextreme.com.

VFO and System Control

The VFO and system control of the ABR-1 is the "heart" of the design and is loosely based on the AAØZZ I/Q Pro VFO. The ABR-1 VFO uses the same Analog Devices AD9854 12-bit DDS synthesizer, but with a single PIC16F877A microcontroller used to handle user input, display, frequency updating, and filter selection. The following user input features are managed by the main microcontroller:

- Band up
- Band down
- VFO frequency step size
- Mode (CW, USB, LSB)
- Main tuning encoder
- RIT enable
- RIT encoder

Each push button control uses a single input pin on the PIC. The encoders use 2 pins each. The remaining pins on the device are used for serially loading the frequency control data into the DDS chip, for LCD display, and for filter and mode relay selection.

Because the ABR-1 is a superhet transceiver designed around an intermediate frequency (IF) of 4.9152 MHz, the VFO frequency must be offset by the correct value with the understanding that the final output frequency needs to take the mixing scheme into account (i.e. addition or subtraction). The software was written with flexibility in mind to allow the user to adjust (or change entirely) the IF frequency used to calculate the actual output frequency of the VFO as a calibration routine. This makes it possible to tweak the output frequency without needing to change source code.

A 4-bit filter selection address is generated by the PIC at startup and when band changes occur. This 4-bit address is applied to a 74154 encoder, which in turn gives us sixteen unique TTL logic level pins. These pins are used to trigger H-Driver circuits for single coil latching relay selection of the filters. Nine pins are used for band pass filter selection, six pins are used for low pass filter selection, and one pin is used for the reset condition, for a total of sixteen pins.

Similar to the I/Q Pro VFO, the reference clock in the ABR-1 VFO is provided by a 125 MHz clock oscillator instead of using the internal 300 MHz internal clock generator driven by a lower frequency reference oscillator. This allows us to generate a cleaner output at the maximum desired frequency. The output of the DDS chip must be low pass filtered, and a cutoff frequency of 40 MHz was chosen in order to use the lower mixing product for each of the supported bands. In the case of the ABR-1, the maximum VFO frequency needed is ~35 MHz (29 MHz + 4.9152 MHz).

The I and Q output amplifiers are the same push-pull amplifiers as those used in the I/Q Pro design and are individually adjustable via a 50 ohm potentiometer. One of the amplifiers is used to drive the receive mixer, while the other is used to drive the transmit mixer. This makes it very easy to adjust the drive to each mixer separately, which is very handy when finding the optimum level for lowest spurious output from the mixers.

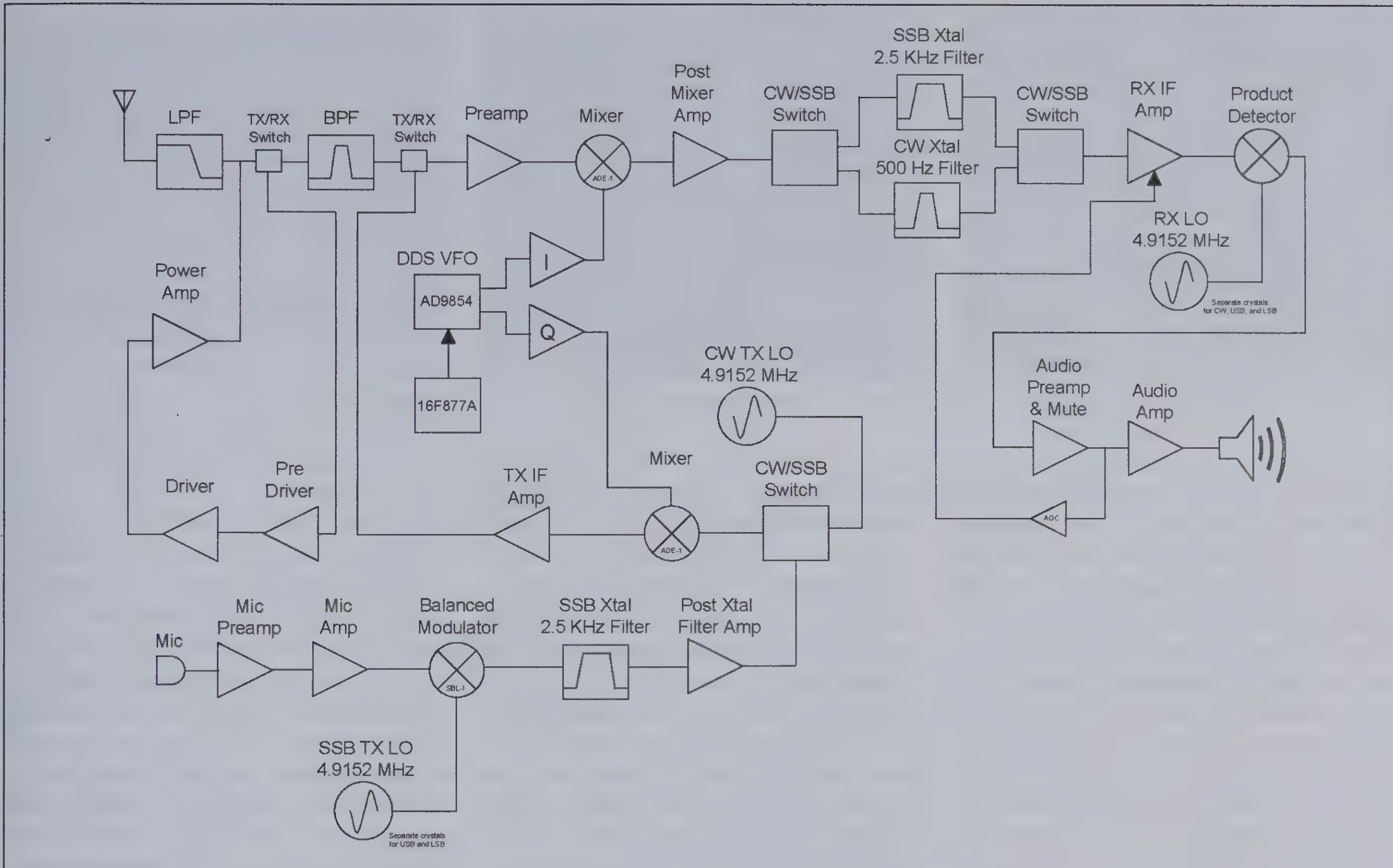


Figure 1—Overall block diagram of the ABR-1.

The VFO frequency and other operating parameters, such as RIT and mode selected, are displayed on a Hitachi HD44780 compliant display.

The ABR-1 PIC16F877A source code listing documents the functionality in detail and should be used as a supplement to this article for further information. It may be obtained from the author by e-mailing him at k8gd@dslextreme.com.

Band pass Filters

There are 9 band pass filters in the ABR-1 which are controlled by the main processor. Each of the filters is a five pole, 50 ohm, doubly terminated band pass filter. Variable trimmer capacitors are used to fine tune the pass band of each filter. Tuning for each of the nine band pass filters takes a fair amount of patience to optimize the filter shape. I used a Tektronix 2710 spectrum analyzer with the built in tracking generator to fine tune the filter shape. It is also possible to use a signal generator with an oscilloscope to sweep the filter and fine tune each of the filters by analyzing the envelope of the waveform.

Figure 2 shows the results for the 40 meter bandpass filter. Figure 2a is the LTSpice simulation plot and Figure 2(b) is the constructed filter.

The band pass filters are used for receiver preselection, and also during transmit to remove unwanted mixing products. Switching is achieved by a receive/transmit changeover DPDT relay. One set of relay contacts is used for the band pass filter, while the other set is used for receive/transmit changeover, which switches the antenna connection between the receiver and transmitter. Hold time for the relay is adjustable via a potentiometer.

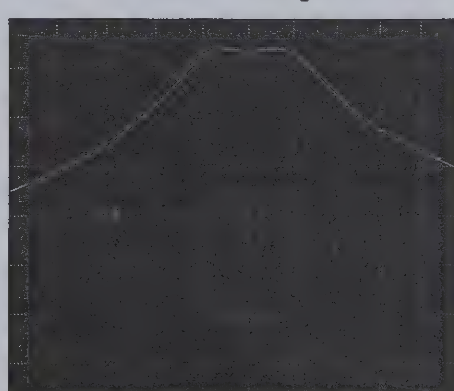


Figure 2(a)—Simulated 40 meter filter passband.

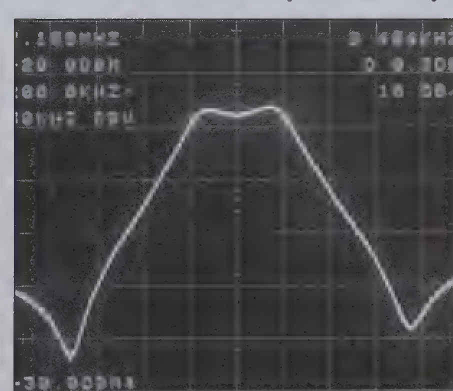


Figure 2(b)—Actual 40 meter filter passband.

Receiver

The ABR-1 receiver is based on the excellent and well-documented 2N2/xx series of CW QRP transceivers designed by Jim Kortge, K8IQY.

Incoming signals are routed through one of the nine preselection band pass filters, each of which is selected by the control sys-

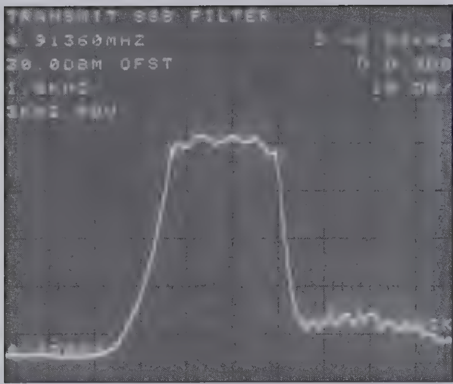


Figure 3(a)—SSB transmitter filter.

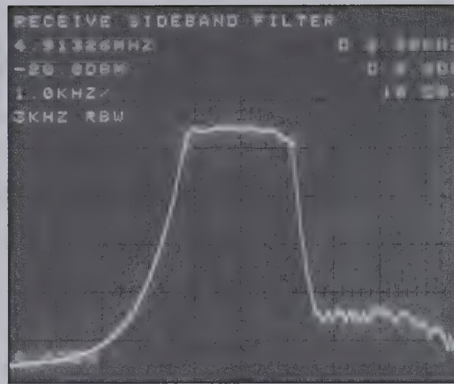


Figure 3(b)—SSB receiver filter.

tem discussed earlier. The filtered signal is passed to the RF Gain control and then on to a +12 dB Norton "Noiseless" amplifier. Following this stage, the signals are routed to the RF input port of a Mini Circuits ADE-1 mixer. Drive from the VFO, at a frequency determined by the control system, is fed into the mixer LO port.

Output from the receive mixer at the IF frequency (4.9152 MHz) is passed through a 3 dB attenuator to provide a constant 50 ohm output impedance for the mixer as well as a stable 50 ohm input impedance to the post mixer amplifier. Overall gain from the post mixer amplifier is approximately 16 dB, with the output from the amplifier feeding a 3 dB attenuator to provide a constant 50 ohm output impedance for the amplifier.

The signals are then routed to a relay, which is used for selection of the CW or SSB filter, depending upon the mode selected. Each of the crystal filters were modeled in the AADE filter design program, which is an excellent filter design tool offered by Almost All Digital Electronics. Models were also created and tested in LTSpice for comparison. The CW filter is a 4-crystal Cohn filter designed to have a bandwidth of approximately 500 Hz. Input impedance into and out of the CW filter is approximately 550 ohms, so appropriate impedance matching techniques are required for good filter response. The SSB filter is a 6-crystal Chebychev design, based on a design created by Jim Kortge after several discussions we had via email and telephone conversations. It is designed to have approximately 2.3 kHz bandwidth. The filter impedance is approximately 1 kohm, so similar impedance matching techniques are required here as well. Figure 3 shows the resulting passband for the SSB transmit and receive filters.

Signals are routed from the crystal filters into the IF amplifier, which has approximately 45dB gain. Spice simulations show that the input impedance to the IF amplifier is approximately 7 ohms. Appropriate matching transformers from each of the crystal filters transform the filter output impedance to match the input impedance of the amplifier. The amplified signals are coupled to the product detector through a 4:1 bifilar wound transformer. The product detector is a single balanced mixer, composed of a 10 turn trifilar wound transformer on an FT37-43 core and 1N5711 Schottky diodes. Local oscillator power is approximately +7 dBm and is routed to the LO port on the product detector. LO frequency selection for each of the modes (CW, LSB, and USB) is selected by switching in 3 separate crystals (one for each mode) to the oscillator circuit via latching relays. Crystal selection is controlled by the main 16F877 microcontroller.

Low-level audio signals found at the output of the product detector are amplified approximately 20 dB in the audio preamp stage. Signals are then routed to the receive mute stage, which is a simple P-type JFET that acts as a switch controlled by voltage applied to the gate. CW side tone is provided by allowing a small amount of audio to "leak" past the mute stage, which is accomplished with a large value resistor connected between the drain and source of the mute transistor when in the CW mode. The resistor is switched in and out of the mute circuit using the other half of the CW receive crystal latching relay in the local oscillator circuit. Audio from the mute stage is routed to both the audio derived AGC detector circuit and the LM386 final audio amplifier.

The AGC detector circuit rectifies the audio, where the DC is smoothed by a memory capacitor and then amplified with an op amp. The output from the op amp drives the S-meter for front panel display, and is also used to dynamically change the gain of the IF amplifier by varying the emitter degeneration on the common emitter stage of the IF amplifier. This provides a simple "ear saving" AGC circuit, although some "pumping" of the audio can be heard when listening to strong signals.

Transmitter

As mentioned before, SSB generation in the ABR-1 is based on the concepts found in the article "The Principals and Building of SSB Gear" written by Doug DeMaw, W1FB, which is a five part series published in *QST* between September, 1985 and January, 1986. This series of articles is an excellent primer in the principals of SSB and was extremely helpful in the design and construction of the ABR-1 and is recommended reading for anyone wanting to explore SSB signal generation.

The microphone amplifier is a two-stage circuit. The first stage uses a simple 2N2222 preamplifier stage that provides initial gain for the second stage, which uses an Analog Devices SSM2167 Microphone amplifier. This small 10-pin surface mount device is an excellent choice for SSB generation. It includes a noise gate and variable compression that provides excellent audio for SSB communication applications. Microphone gain is accomplished with a panel-mounted potentiometer connected between the output of the microphone amplifier and the balanced modulator.

The balanced modulator used in the ABR-1 is a Mini Circuits SBL-1. Audio from the microphone amplifier is routed to pins 5 and 6 on the IF port which apply audio to the diode ring through one set of trifilar windings in the mixer. Local oscillator energy is applied to the mixer on the RF port at a level of +7 dBm. The mixing produces a double sideband suppressed carrier signal at the IF frequency of 4.9152 MHz and is available at the LO port of the SBL-1 mixer.

The scheme for creating the local oscillator signal is identical to that of the receive stage in the ABR-1. Latching

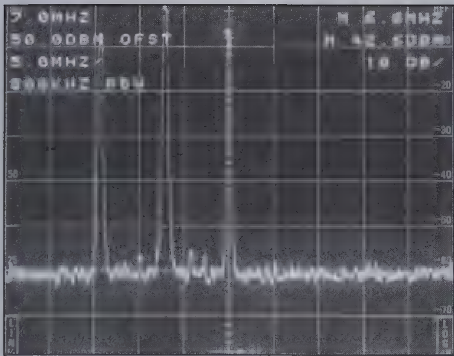


Figure 4—40 meter output spectrum.

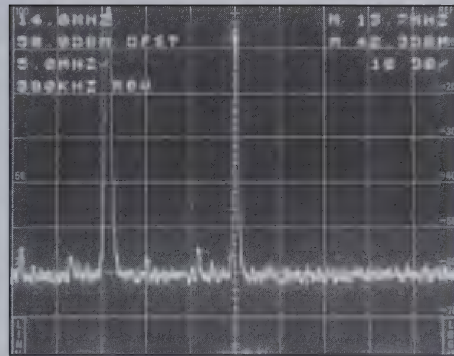


Figure 5—20 meter output spectrum.

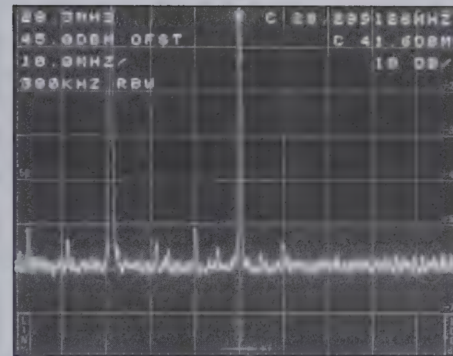


Figure 6—10 meter output spectrum.

relays are used to switch three different crystals (USB, LSB, or CW) into the oscillator circuit based on mode selection provided by the controller circuit. LO frequency is fine tuned by "rubbering" the crystal frequencies using a series inductor and trimmer capacitor on the crystals.

Output from the balanced modulator is routed to a crystal ladder filter to remove the opposite sideband (DSB becomes USB), through an 820 ohm resistor to match the 50 ohm output impedance of the balanced modulator to the ~1 kohm input impedance of the crystal filter. The transmit crystal filter is the same design used in the receiver. Signals from the crystal filter are routed to a +40 dB amplifier. This amplifier is used to recover the losses that occur in the balanced modulator and the crystal filter and bring the level up to +7 dBm for mixing with the VFO signal. The output from the amplifier is routed to a latching relay. The relay is used to select which IF signal is used for mixing, which is determined by the mode selected by the user (i.e. USB, LSB, or CW) and controlled by the main microcontroller. If USB or LSB is selected, the path through the balanced modulator, crystal filter, and post filter amplifier is used. If CW is selected, the signal from the LO is used directly for mixing.

The output from the relay is fed to the LO port on a Mini Circuits ADE-1 mixer, with a 51 omh resistor between the LO port and ground to provide a stable impedance seen by the mixer. The VFO signal is applied to the RF port on the mixer. Drive control for the RF port is adjusted in the VFO circuit mentioned previously. Output from the transmit mixer is fed through a 3 dB attenuator to provide a stable 50 ohm output impedance. It is extremely important to have the mixer "see" its characteristic impedance at each port to minimize spurious output. This was one of the biggest challenges to overcome while building the ABR-1. Following the mixer, signals are routed into a Linear Technologies LT1252 video amplifier. This amplifier proved to be an exceptionally good broadband amp and allowed me to easily make a variable gain amplifier by using a potentiometer to control the feedback resistance, thus controlling post mixer amplifier gain.

The signal from the post mixer amplifier is routed to the band pass filters to remove the unwanted mixing product. The band pass filters are the same ones used as for preselection in the receiver. The TX/RX changeover relay switches the filter use between transmit and receive. This scheme works well, and a fast relay (i.e. reed relay) can be used for very fast switching time.

After the signal is filtered, it is routed to the transmit amplifier, which is comprised of pre-driver, driver, and final amplifier stages. Several final amplifier designs were built and evaluated, with the end result being based on the Motorola AN779L broadband 20 watt HF driver amplifier. An amplifier kit is available from Communication Concepts and uses Motorola MRF475 and MRF476 transistors. I used the amplifier circuit board and components, but used 2SC2075 and 2SC1969 transistors as the driver and final transistors respectively. These devices work very well in this application and are much less expensive than their Motorola counterparts.

Finally, signals from the final amplifier are low pass filtered, with filter selection provided by the control circuit, once again through latching relays. Signals are very clean with low harmonic content. Examples of the transmitter output are shown in Figures 4 through 6. In each case, the center peak in the plot is the fundamental signal at approximately +42 dBm (15 watts). The peak to the left of the carrier is the 0 Hz marker. As the figures show, the highest spurious output for 10 meters and 20 meters is –48 dBc. The highest spurious response for 40 meters is –50 dBc. Other bands are similar.

Additional Features

In addition to the features described above, a transceiver like this wouldn't be complete without a few "bells and whistles." A memory keyer is a necessary feature and I was able to easily incorporate a DL4YHF memory keyer circuit into this design. This is an extremely robust design and uses a PIC16F84A microcontroller. More information can be found at http://www.qsl.net/dl4yhf/pic_key.html.

After using the ABR-1 for several months, I found myself wanting a receive preamp for the higher HF bands at times during weak band conditions that I could switch in and out as needed. I added a simple +15dB preamp to the front end that is selected via a front panel push button. A small PIC16F84A coprocessor is used to perform the relay selection, and tell the main processor that the preamp is active so a message can be written to the LCD screen.

Rounding out the feature set, I also added the Switched Capacitor Audio Filter available from the New England QRP Club. This is a very high quality audio filter and a front panel push button is available to switch the filter in and out of circuit using the same coprocessor used in the preamp circuit. More information on this excellent filter can be found at http://newenglandqrp.org/nescaf.

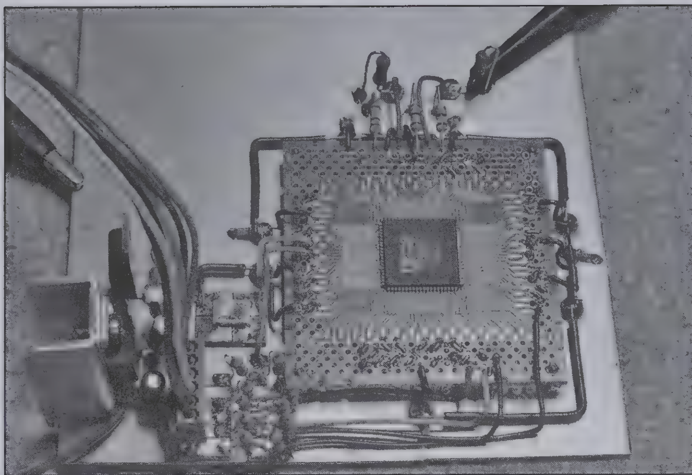


Figure 7—Mounting for the AD9854 synthesizer chip.

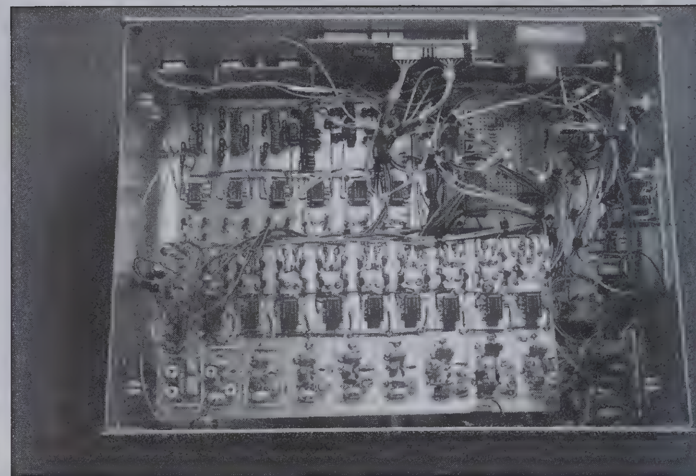


Figure 8—Inside the ABR-1.

Construction

The ABR-1 is built almost completely using the Manhattan construction technique. The main microcontroller circuit is built using "perf board", as this was much easier when working with the PIC16F877A, which is a 40-pin DIP package device. The Manhattan pads were created using a Harbor Freight sheet metal punch. Before mounting each pad to the substrate board, they are filed on the "glue" side to ensure a good bond between the pad and substrate using super glue.

The Analog Devices AD9854 DDS chip is available in an 80-pin LQFP surface mount package, and proved to be a tricky part to use in a prototype application. To mount the device, I used a prototype board from Schmartboards. Soldering surface mount devices becomes quite simple when using these prototype boards. I used the 202-0011-01 for the AD9854, which will accommodate LQFP devices from 32 to 100 pins. The device pins lay in channels on the circuit board, which are pre-tinned with solder. To solder the device to the circuit board, I taped one side of the AD9854 to the circuit board and applied liquid flux to the pins to be soldered. Using a soldering iron with a tip width smaller than the pin pitch (.5 mm pitch in the case of the QFP used in the AD9854), I pushed the solder up into the pin along the channel. A 10x loupe to magnify the work was used and made soldering and inspecting my work much easier. Once one side of the device is soldered in place, the tape can be removed and the remaining pins can be soldered. PCB traces fan out to the edges of the prototype board where connections can be made. I attached the prototype board to the substrate board by using short bits of solid core wire on each connection where a ground is needed on the DDS chip, and then soldered those short pieces of wire to the ground plane. This provided a very sturdy mounting arrangement, as shown in Figure 7. More information can be found at the Schmartboards website, http://www.schmartboard.com/.

The other surface mount device used in the ABR-1 was the microphone amplifier. For this small 10-pin device, I used a prototype board from Jackson Harbor Press. The microphone amplifier was mounted to the board, and then this small board was glued to the substrate board where Manhattan connections could be made.

The enclosure used for the ABR-1 is the Ten Tec BK-1259, a very nicely manufactured enclosure with a variety of internal mounting options for the boards and controls. Figure 8 shows the result. Ten Tec also supplied the VFO knob for a very reasonable price, and is the same one used for the Orion II.

Surprisingly, the most questions I have received about the ABR-1 are about how I created the front panel. The push buttons used for function selection I found at Midwest Electronics Surplus in Fairborn, OH. These are large, square black momentary switches that I mounted (Manhattan style of course) to small circuit boards that are affixed to the front panel using flush mount screws. The square holes in the front panel for the buttons, LCD display, and meter were cut by hand using an Adel Nibbler tool and small files. The front panel was designed in Adobe Photoshop and printed on a color laser printer at my local PostNet store by their very helpful and friendly staff. The front panel printout was simply cut to size and then mounted to the metal enclosure front using double sided tape and the rotary control mounting nuts. It's a quick and easy way to get very professional looking panel designs.

Future Plans

Most designers will admit that there is always room for improvement, and the ABR-1 is certainly no exception. One area I will be investigating further is to modify the design and change the IF amplifier to the Hybrid Cascode AGC Amplifier, which was presented by Wes Hayward at FDIM 2007. The biggest area of improvement gained here is that the AGC will be IF derived as opposed to audio derived and offer much more dynamic range. Additionally, I want to rework the audio chain to offer a bit more gain and less noise. This will pair nicely with reworking the IF amplifier.

Acknowledgements

I would like to thank Jim Kortge, K8IQY, for his encouragement and Elmering over the years and the ability to use his receiver design for the foundation of the receive circuit in the ABR-1. I would also like to thank Craig Johnson, AAØZZ, for the excellent work and inspiration in the area of DDS and PIC microcontrollers. I would also like to thank my wife Patti for her encouragement and putting up with me spending lots of time in the shack designing, building, debugging, and documenting the ABR-1. ●●

A Phasing Type Transceiver for the 60 Meter Band: Part 2

Paul Alexander—WB9IPA wb9ipa@gmail.com

Part 2 of this article begins with a continuation of the Quadrature Modulator description:

A Johnson counter was chosen to provide the in-phase and quadrature RF signals over analog methods because it provides a precise 90 degree shift over a fairly wide frequency range without adjustment. The counter circuit in this design has been tested with an input frequency of 133 MHz, with satisfactory results. Most analog RF phase shift circuits provide accurate quadrature phase shift for only a small range of frequencies and become very complicated when multiband operation is contemplated [8].

Regardless of how much planning and calculation is put into attempting to predict the correct phase rotation of the Johnson counter, Murphy's Law always seems to demand the opposite rotation from what you have provided. As a hedge against Murphy's effects, as set of jumpers were provided between the Johnson counter and QSD. Resistors R86, R87, R88 and R89 are zero-Ohm jumpers which allow both S0 and S1 of the QSD to be individually selected to the 0 or 90 degree output of the counter. In this unit, R88 and R89 were populated, while R86 and R87 were not installed.

A 3 dB attenuator is provided at the output of U18 to provide a somewhat consistent load to the modulator, regardless of the load after the attenuator.

The modulated RF signal is applied to the input of amplifier Q5 (see Fig. 13), where it is amplified by about 8-10 dB before leaving the exciter board via J3. While this stage does amplify the modulator signal, its main purpose is to further stabilize the load seen by the modulator, U18. Both emitter degeneration (R81 and R103) and shunt feedback (R106) are employed to help stabilize the gain and input impedance of the amplifier over frequency. At 3 MHz, the amplifier exhibits an input impedance of 98 ohms with a gain of 11 dB, and Zout = 68 ohms with a gain of 10 dB at 30 MHz. Q5 is operated in class A with approximately 27 mA of standing current. A heatsink is recommended to keep Q5 cool when supply voltage exceeds 13 volts.

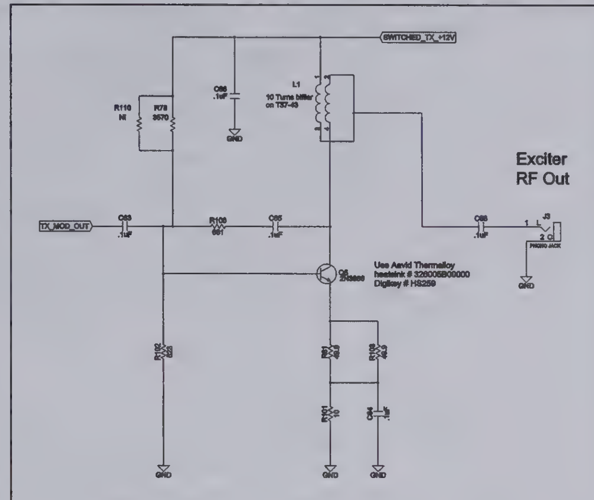


Figure 13—Exciter output amplifier.

Figures 14 and 15 are not shown here, but are available online (see the note at the end of this article). They show miscellaneous connections to other modules in the transceiver system.

Receiver Module

The receiver module is a single-signal, direct conversion design, which is capable of receiving Single Sideband (SSB) and CW signals over a range of <100 kHz to 30 MHz. Receiver adjacent channel selectivity is provided by an audio filter chain consisting of a four pole, highpass filter, followed by an eight pole, lowpass filter. Automatic Gain Control (AGC) is provided to maintain a constant audio level despite wide variations in RF signal level. The audio output amplifier is capable of driving >1 watt into an 8 ohm loudspeaker, providing sufficient audio drive level for use in noisy environments. This module does not provide local oscillator generation or receiver front end selectivity; these functions are provided by the OSC_FILTER module.

The receiver module operates from a power supply of 10-15 VDC. The measured Minimum Discernable Signal (MDS) of the receiver is –127 dBm and the Two-Tone Third Order Dynamic Range is 87 dB. The undesired sideband is suppressed by approximately 35 dB. Local oscillator leakage (as measured at the

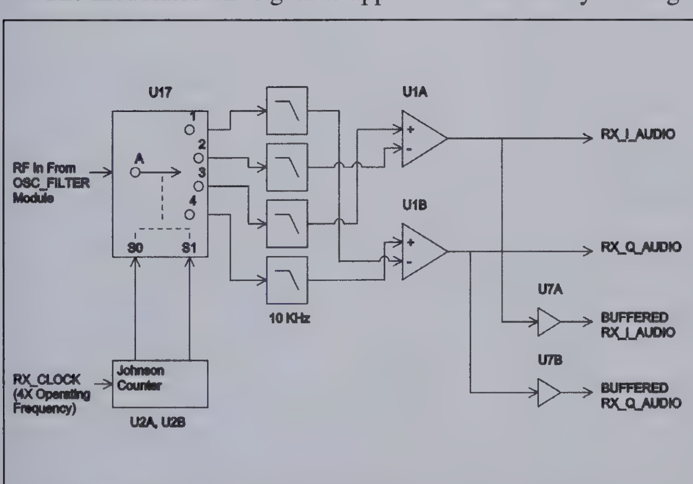


Figure 16—Receiver front end block diagram.

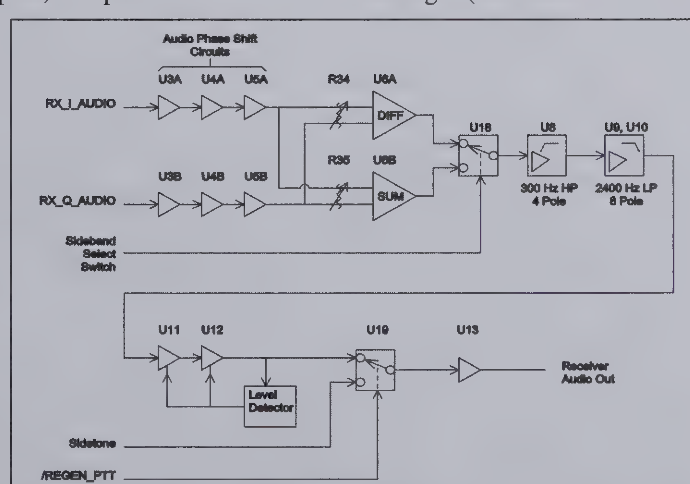


Figure 17—Block diagram of the receiver audio sections.

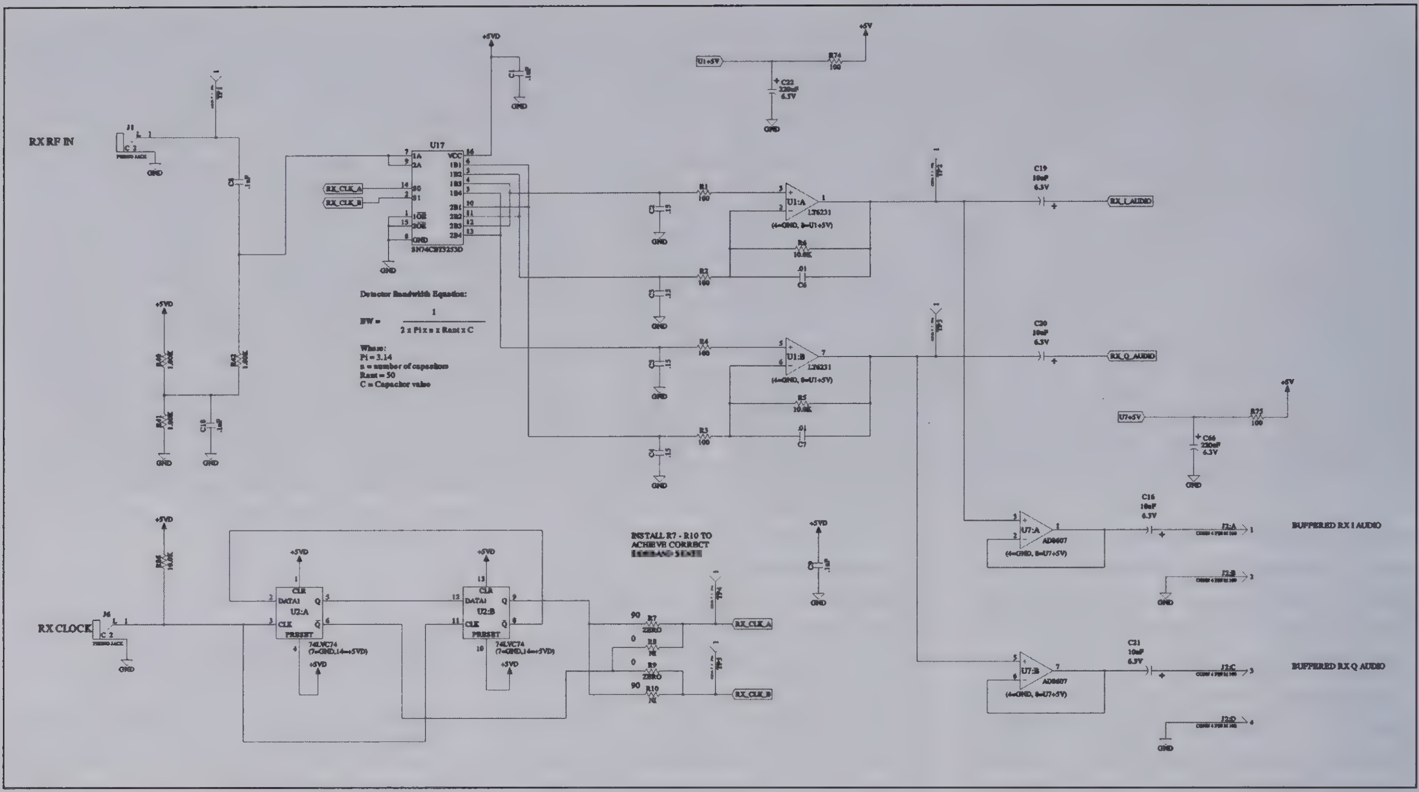


Figure 18—The receiver front end circuitry, including sampling detector, Johnson counter, and audio output buffers.

transceiver antenna terminal) is —43 dBm.

Block diagrams of the receiver can be seen in Figures 16 and 17.

Figure 18 is the circuit diagram of the receiver front end. RF signals, which have been previously band-limited by filters on the OSC_FILTER board, enter the receiver module via connector J1. From here, the RF is passed to U17, which is a dual, single pole four throw solid state analog switch, configured as a Quadrature Sampling Detector (QSD), also known as a Tayloe detector [1, 2]. Capacitors C2, C3, C4 and C5 are chosen such that, when combined with a 50 ohms signal source

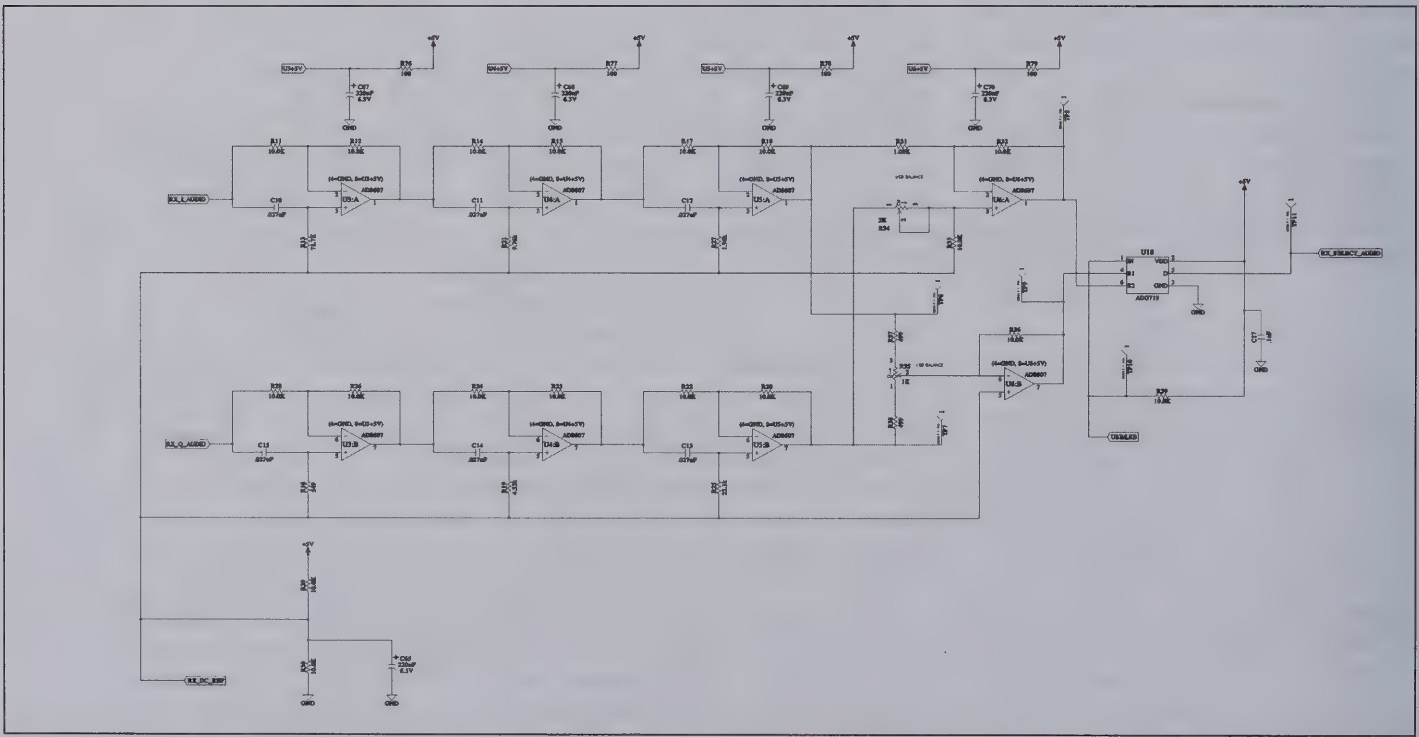


Figure 19—Audio phase shift circuitry, including the phase shift network, sum and difference amps, and sideband switching.

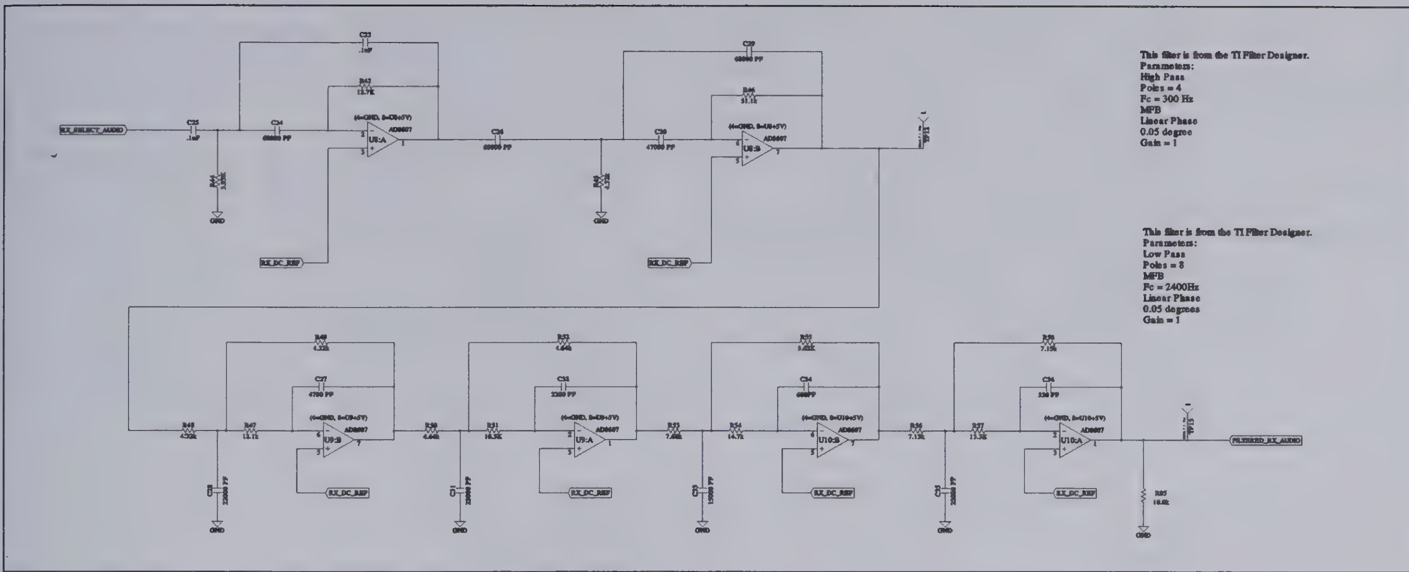


Figure 20—Receiver audio filters, using active 300 Hz highpass and 2400 Hz lowpass designs.

impedance from the RX INPUT, each forms a lowpass filter with a cutoff frequency of approximately 7.9 kHz. The signals developed across C2, C3, C4 and C5 are then amplified and further lowpass filtered by U1A and U1B. Each of these amplifiers has a lowpass cutoff frequency of approximately 16 kHz.

After the signal has been detected in U17, U1A and U1B produce two audio signals: RX_I_AUDIO and RX_Q_AUDIO. These signals are identical in their information content and amplitude, but, are separated in phase by 90 degrees. A portion of these signals is sent to buffer amplifiers U7A and U7B for use in offboard Software Defined Radio (SDR) experiments, or other uses. RX_I_AUDIO and RX_Q_AUDIO are also sent to the audio phase shift circuits (sheet 2) for further processing.

Clocking for the QSD is provided by U2A and U2B, which form a quadrature counter. RX CLOCK enters the receiver module at 4X the operating frequency and is divided by U2A and U2B to produce four separate signals at the operating frequency, each separated in phase by 90 degrees. R7, R8, R9 and R10 are 0 Ohm jumpers which are selected to be installed as needed to obtain the correct sideband selection sense. In this example, correct sideband sense was achieved when R7 and R9 were installed; R8 and R10 were not installed.

In Figure 19, U3, U4 and U5 form a wideband audio phase shift network, which is configured identically to that in the exciter module. The network was designed using the J-TEK Allpass Filter Designer to provide a 90 degree phase differential over the range of 200 to 4000 Hz. The passive components used in this network are identical to those in the exciter.

A difference amplifier (U6A) takes the difference between the audio signals at the outputs of U5A and U5B to extract the upper sideband (USB) audio signal. Potentiometer R34 is used to adjust the amplitude balance of the two signals, in order to obtain the deepest null of the unwanted lower sideband (LSB) possible.

U6B is configured as a summing amplifier, which sums the output voltages of U5A and U5B to recover the LSB audio signal. Potentiometer R35 adjusts the amplitude balance of the two input signals to null the undesired (USB) signal. The desired sideband audio signal is selected by means of U18, a solid state switch. Control of U18 is by means of a front panel switch with USB being selected by a logic high (or open) and LSB with a logic low (or ground). The same signal controls sideband selection in the exciter. This signal is compatible with 5 volt logic levels, opening the possibility of control via a microcontroller port pin.

Figure 20 shows the audio filtering circuitry. The selected sideband audio (RX_SELECT_AUDIO) passes into a four pole, highpass, active filter consisting of U8A and U8B and having a cutoff frequency of 300 Hz. The signal next passes through an eight pole, lowpass filter consisting of U9A, U9B, U10A and U10B, with a cutoff frequency of 2400 Hz.

While the filters in the receiver appear similar to those in the exciter, they have quite different response characteristics. In the first version of this receiver, both the high and lowpass filters had Tchebychev responses, identical to those in the exciter. The advantage of the Tchebychev response is that it has a very sharp rolloff beyond the cutoff frequencies. Unfortunately, a negative attribute of the Tchebychev filter response is the large amount of phase distortion and ringing that occurs throughout the passband, giving the receiver a very unpleasant sound. In the end, another filter was designed which has a near linear phase response. While this filter has a more gradual rolloff outside the passband, the sound is much more pleasing to the ear.

Other authors [5, 13] advocate the use of LC audio filters in their receivers. LC-type filters produce extremely low levels of internally-generated noise, the inductors used in those filters are susceptible to picking up noise from external magnetic fields, such as those generated by motors and computer monitors. Elimination of this effect was the major motivation behind the decision to use active filters, whose parameters are set by resistors and capacitors. RC-type active filters also give us a circuit whose parameters are set by components (resistors and capacitors) which are physically small, readily in a wide range of values and conducive to the

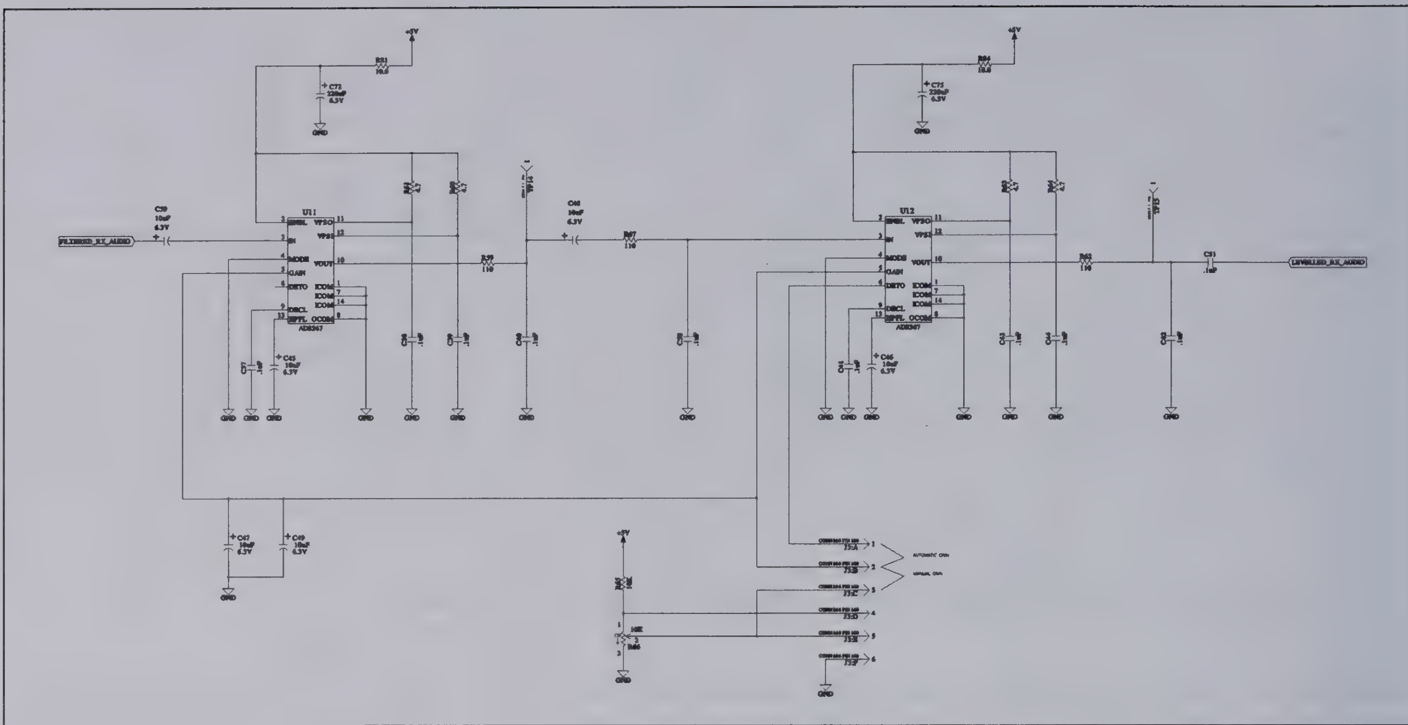


Figure 21—Audio AGC circuitry.

use of SMT components.

Audio AGC and power amplifiers are shown in Figure 21. U11 and U12 form a variable gain amplifier (VGA) which provide a maximum gain of about 90 dB to the receive signal path. U12 contains a detector, which converts the output signal to a varying DC voltage, in proportion to the RMS value of the signal at the output of U12. This proportional DC voltage is applied to the gain control pins of both U11 and U12, providing a means of AGC for the received signal. It is recognized that there are times that AGCl is not desired; for that reason, manual gain control has also been provided. A short across pins 1 to 2 of J3 will complete the AGC loop, causing AGC action to occur. Putting a short across pins 2 to 3 of J3 allows the gain to be controlled by means of a voltage applied to pin 5 of J3. This voltage can be obtained from R66 (if installed), or, by the use of an external 10 kohm potentiometer connected to pins 4, 5 and 6 of J3. Both R66 and the external potentiometer should not be installed at the same time. Capacitors C47 and C49 control the time constants of the AGC system. Increasing capacitance increases both the attack and release times. The values shown appear to be good starting values for SSB operation. Operation of the AGC system has been quite good. The only time manual gain control has been used has been during receiver adjustment and testing.

In Figure 22, LEVELLED_RX_AUDIO from the AGC amplifiers is sent offboard to the volume control, which is a 10 kohm potentiometer. This potentiometer should be an audio taper unit, if possible.

When the audio returns to the board, it next goes to U19, a solid state switch which selects receiver audio, or TX_SIDETONE from the exciter board, dependent on the level of the /REGEN_PTT line. When /REGEN_PTT is high (or open), receive audio is selected. Conversely, when /REGEN_PTT is low (or ground), TX_SIDETONE is selected.

The audio signal from U19 is passed to audio power amplifier U13, where it is amplified to a level suitable for driving a loudspeaker. A snubber network, consisting of C60 and R73 prevent oscillation of U13. The amplified audio is capacitor coupled to J7 for connection to an offboard

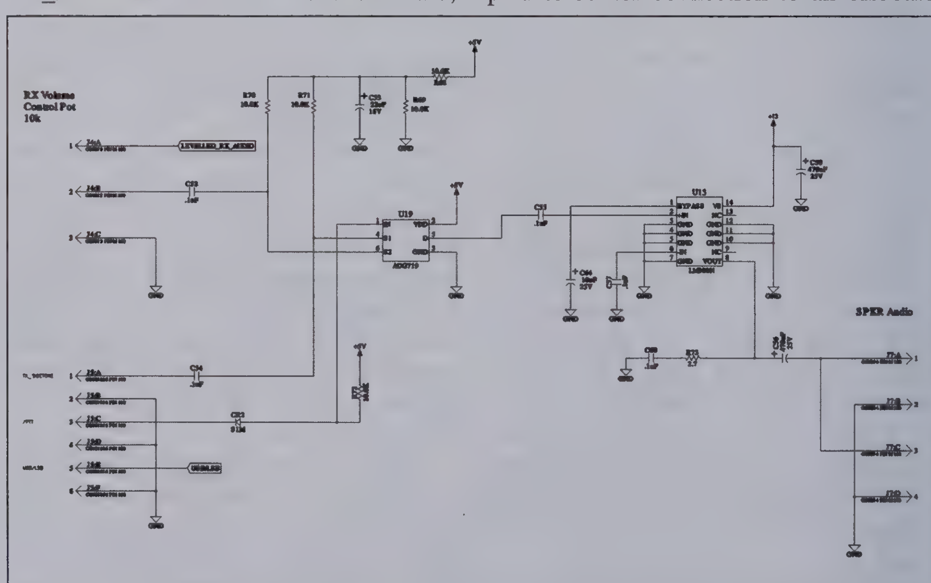


Figure 22—Audio power amplifier and audio switching circuits.

loudspeaker. The loudspeaker should be rated for 8 ohms and capable of handling a minimum of 1 watt.

Main power, nominal 12 VDC, enters the board through J8. Q2 is a P-channel MOSFET, which provides protection of the module circuits in the case reverse polarity main power is applied. The use of a P-channel MOSFET provides less voltage drop than a series diode and does not result in a blown fuse, as would be the case with a parallel protection diode.

The polarity protected supply voltage is applied to linear regulators U14 and U16 to provide regulated 5 VDC to the +5V and +5VD rails, respectively. Separate regulators were provided for the +5V and the +5VD rails not for noise isolation, but rather, to provide more choices for the component to be used in U17. U17 is an SN74CBT3253D, and is used in the QSD. This part is available in both 3.3 and 5 volt versions. Powering the +5VD from a separate regulator allows the use of either the 3.3 or 5 volt versions of U17 by simply changing regulator U16 to the appropriate type. Connections to the receiver module can be seen in Figure 23 (available online).

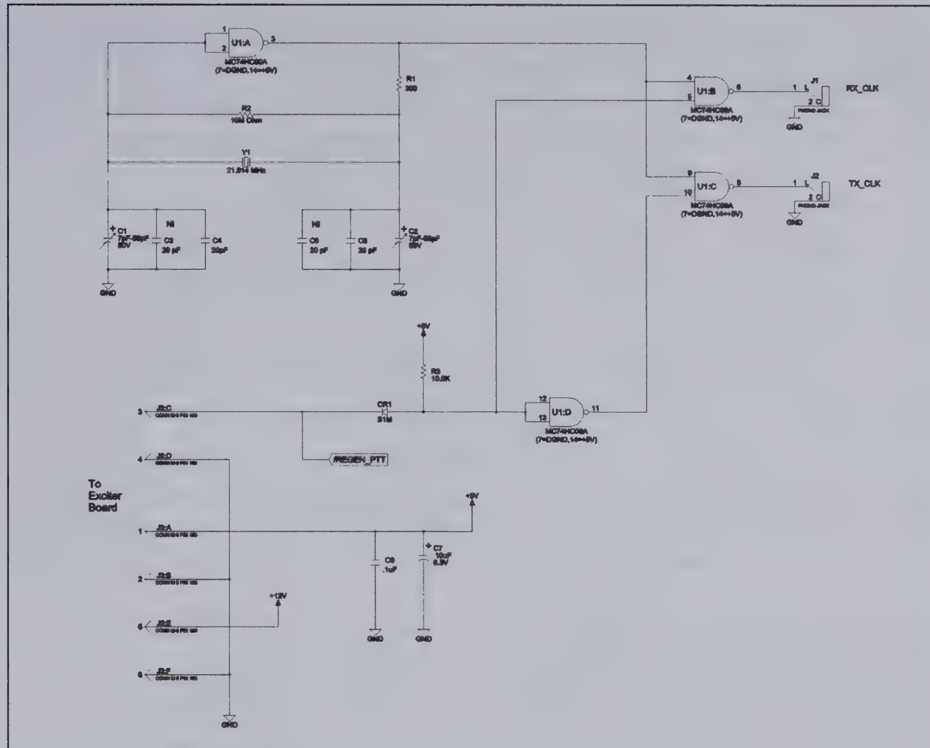


Figure 24—Clock oscillator circuit.

Oscillator-Filter Module

The oscillator-filter module is responsible for generating the RX_CLOCK and TX_CLOCK signals for use by the receiver and exciter modules, providing RF bandpass and low pass filtering for both receive and transmit functions, as well as antenna switching. As designed, this module provides for operation of the transceiver on a single, crystal controlled channel within the 60 meter allocation. Modification for use on other frequencies would be possible. A temperature stabilized crystal oscillator circuit is used for frequency generation to ensure a frequency stability of better than 5 parts per million over a wide range of temperatures. The oscillator-filter module derives its operating power from the exciter module.

In Figure 24, U1A forms a Pierce crystal oscillator, which generates a clock signal at four times the operating frequency. The clock signal is then sent to U1C and U1D, where it is buffered and gated to either the exciter via J2 (TX_CLK) or J1 (RX_CLK), depending on the logic level of the /REGEN_PTT.

Since the transceiver was intended to be operated in mobile, portable and home environments, it was felt that some sort of temperature stabilizing scheme should be included to keep the transceiver as close to the assigned frequency as possible over the expected environmental temperature range. During the winters, outside temperatures routinely drop below 0 C (32 F) and exceed 32 C (90 F) in the summer. While FCC 97.303, which governs operation on the 60 meter band, makes no reference to any frequency accuracy specification, it was simply felt that good operating practice would encourage keeping to the assigned frequency as closely as possible, without the use of "exotic" measures.

The stabilization scheme chosen was to simply scatter Positive Temperature Coefficient (PTC) thermistors around the oscillator section, as well as bonding one to the crystal. PTC thermistors behave like normal resistors in that they dissipate power (heat) in response to current passing through them. However, PTC thermistors exhibit a unique behaviour, in that their resistance increases as the temperature increases. This temperature to resistance relationship is very non-linear; in fact, the change becomes very rapid above a temperature known as the Transition Temperature. This property can be exploited to make a very simple, self-regulating heater. When the device is below the transition temperature and voltage is applied, heat is dissipated in the device. Heat is conducted out of the thermistor and into the circuit board where it heats the board and nearby components. When the thermistor reaches the transition temperature, its resistance rapidly increases, lowering the power dissipated in the device. This action causes the thermistor to act as a heat source whose temperature is maintained at a nearly constant temperature near the transition temperature. Since heat is being conducted out of the thermistor and into the circuit board, nearby components are held at relatively stable operating temperatures, despite varying environmental temperatures.

The thermistors used in this design were chosen to have a transition temperature of 65°C. Approximately 2 watts of power (at a supply voltage of 12 VDC) can be dissipated in the thermistors while below the transition temperature. This power drops considerably after the temperature has stabilized and is dependent upon thermal losses to the ambient environment.

In order to increase the effectiveness of the thermistors, slots were cut in the PCB material to thermally isolate the oscillator section from the rest of the board. A small

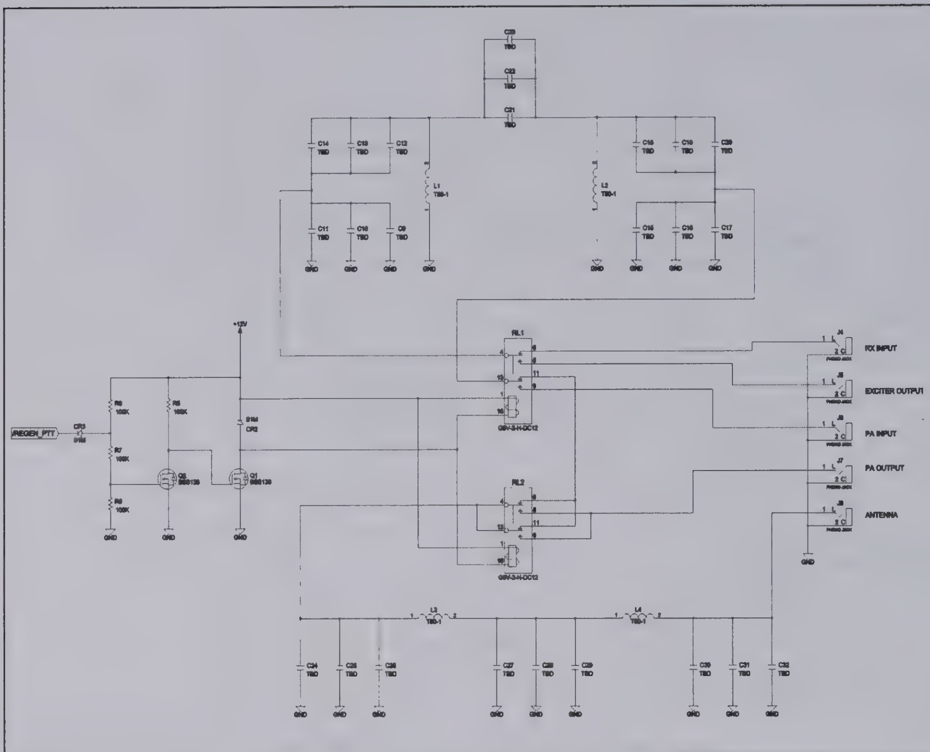


Figure 25—Receiver input filter, transmit output filter, and associated switching circuitry and relays.

enclosure was built around the oscillator section to further thermally isolate the oscillator from the environment. The enclosure was built from layers of foam board. Foam board consists of a sheet of some type of plastic foam with heavy paper bonded to the outer surfaces and is available from art supply stores. Squares of the material were cut, removing material that would interfere with the components, and layers built up until the entire oscillator section was contained. An additional piece was made to cover the bottom of the oscillator. The layers of foam were pressfit over #6 nylon hex spacers to hold them in place.

If the transceiver will be operated in a benign environment where the temperature will be somewhat constant, the heaters are not necessary. When needed, the heaters are enabled by placing a short across J9, pins 1 and 2. Considerable power savings can be had by disabling the heaters when not needed.

During the course of debugging of the oscillator, a change was made to the original trimming capacitor configuration. The original configuration had C2 populated with a 7-50 pF surface mount trimmer and C1 not populated. It was noted that while this configuration did function as intended, it was difficult to accurately set the frequency with C2. In the end, both C1 and C2 were removed, and a 3-13 pF ceramic trimmer from the junk box was added across Y1. This configuration seems to provide enough frequency range to adjust the frequency as needed, while not being overly touchy.

Another (surprising) property that was discovered during debugging was the degree of frequency sensitivity due a change in supply voltage. Varying the supply voltage from 4 to 5 volts would cause approximately 200 Hz shift in oscillator frequency. 200 Hz for a 1 volt change in supply voltage was somewhat more than was expected. This sensitivity to supply voltage is not a problem in this design as the oscillator receives regulated +5V from the exciter module.

Figure 25 shows the T/R relays and input/output filters. When the transceiver is in the receive mode, /REGEN_PTT is logic high. This causes transistor Q2 to conduct, which drives transistor Q1 into cutoff (no conduction), leaving relays RL1 and RL2 in their relaxed state. CR2 is a clamping diode which prevents inductive kick of the relay coils from destroying Q1.

RF from the antenna enters J8 (ANTENNA) and passes through a halfwave, lowpass filter consisting of L3, L4 and their associated capacitors, to RL2, pins 13 and 4. The signal exits RL2 via pins 6 and 11, where it then enters RL1 at pin 11. The signal passes through RL1 and exits at pin 13, where it then enters a bandpass filter consisting of L1, L2 and associated capacitors. The filtered RF signal leaves the bandpass filter and comes to RL1, pin 4. The signal exits RL1 at pin 6 and leaves the board via J4 (RX INPUT) for use by the receiver module.

To visualize the signal paths, block diagrams of the filter switching in both the receive and transmit modes can be seen in Figures 27 and 28 (available online).

When the transceiver is in the transmit mode, /REGEN_PTT is logic low. This causes transistor Q2 to be in a cutoff condition, driving transistor Q1 into saturation (maximum conduction), causing relays RL2 and RL1 to pull in.

RF from the exciter module enters the board at J5 (EXCITER OUTPUT) and enters RL1 at pin 8. The signal passes through RL1 and exits via pin 4, where it then travels to the bandpass filter, consisting of L1, L2 and associated capacitors. The filtered signals returns to RL1 at pin 13, exits at pin 9 and leaves the board at J6 (PA INPUT).

After leaving the board, the signal enters the RFPA module and is amplified to a usable power level. The amplified signal returns to the board via J7 (PA OUTPUT) and is applied RL2, pins 8 and 9. The signal exits RL2 at pins 4 and 13, and is sent to the halfwave lowpass filter consisting of L3, L4 and associated capacitors. After being lowpass filtered, the signal leaves the board via J8 (ANTENNA) where it is ready to be connected to the external antenna. Connections to the Oscillator-Filter module can be seen in Figure 29 (available online).

The final installment of this article will appear in the next issue of QRP Quarterly, *Summer 2008.*

Some of the figures for this article are very detailed and may be difficult to read in print. Others describe the author's specific method of construction and are not included in this version. All original figures are available on the QRP ARCI web site: www.qrparci.org. ●●

QRP Contests

Jeff Hetherington—VA3JFF contest@qrparci.org

Another quarter has passed us by, and it's time to look back at the contests that we've all enjoyed. Last quarter we participated in some of our old favorites, such as the Holiday Spirits Homebrew Sprint and a brand new contest for us, the inaugural VHF Contest.

MARK YOUR CALENDARS!

Hootowl Sprint
May 25, 2008

milliWatt Field Day Contest
June 28-29, 2008

Summer Homebrew Sprint
July 13, 2008

Silent Key Memorial Sprint
August 16, 2008

End of Summer Digital Sprint
September 14, 2008

The Top Band Sprint made for some excellent operating possibilities. Twenty-nine entries were submitted, and judging from the logs, there were many more participating that never submitted their logs. Please, submit your logs and let the world see how much fun we're having with these contests. The winner was Frank Scutch, W4FMS, with a total of 44,982 points. Following on his heels, in a battle of Pennsylvania, Mike Michaels, W3TS, edged out Charles Fulp, Jr., K3WW, with a score of 28,800 to 22,211. Rounding out the top five were Arnold Olean, KØZK, with 12,446 points and Charles Moizeau, W2SH, with 11,921 points.

The Holiday Spirits Homebrew Sprint is always a popular contest for us, and 2007 was no exception. Again, there seemed to be more callsigns in the logs than there were entries, but 50 stations did submit logs! Leading the way was Bob Patten, N4BP, with a total of 261,525 points, more than double the second place finisher. I guess that K3 is functioning pretty well. As an aside, the K3 will not be classified as "Homebrew" for the 2008 running of the Holiday Spirits Homebrew Contest or the Summer Homebrew Contest. Popular opinion expressed during the lead-up for the 2007 Homebrew contests seemed to indicate the wish of our members to not classify the modular build of the K3 as homebrew, and instead stick more closely to the solder-in-hand method of homebrewing, be it scratch built or electronics kits. In a really tight race, second through fifth spots were separated by less than 10,000 points. Second place went to Mert Nellis, WØUFO, with 95,934; Mike Bray, K8DDB, came in third at 95,320; John T. Lainey III, K4BAI, finished fourth with 89,628 points; and Mike Michaels, W3TS, took fifth place honors with 86,240 points.

The first running of the VHF contest was an exciting affair for those that participated. The top spot was also a tight battle between Donald C. Younger, W2JEK, and Bob Patten, N4BP. In the end, the QRP power multiplier and local grid multipliers on 2m FM of W2JEK edged out the 100W effort of N4BP to take top honors. W2JEK scored 3,640 points while N4BP managed 3,552 points on 6m with 100 watts. Paul Stroud, AA4XX, took third place honors with 154 points, and Robert M. Hajdak, N8QE, was the only other member to top the 100 point plateau with 120 points.

The Fireside Sprint ran in February, and, at least around this part of the world, it was certainly worth it to curl up by the fire. An extreme cold and snowy spell set onto the south of Ontario, and my fireplace was too far from the radio to participate. Bob Patten, N4BP, did get on the air and his total of 75 QSOs lead the way to give him 42,336 points. Paul Stroud, AA4XX, also got on the air and his total of 54 QSOs earned him 28,392 points and a second place finish. Randy Shirbourn, NDØC, took third place with 10,556 points in a tight battle with fourth place finished Jeff Embry, K3OQ.

The first QRP-ARCI Contest Championship ran during the 2007 Contest Season. This was where your entries from the individual contests were tallied to give a total standing for all of 2007. To be eligible, an operator needed to enter at least three eligible contests, and their top five finishes would be considered for their QCC Score. We are proud to announce our 2007 QRP-ARCI Contest Champion is Bob Patten, N4BP. Bob scored a total of 218 QCC points out of a maximum possible score of 220! As dominating a perfor-

2007 QRP ARCI Contest Championship Results

Pts	Callsign	Operator
218	N4BP	Bob Patten
213	W2AGN	John L. Sielke
193	K3HX	Tim Colbert
185	VA3RKM	Robert MacKenzie
167	K4BAI	John T. Lainey III
166	WØUFO	Mert Nellis
166	AI2T	Barry Ives
163	K4KSR	Bill Cunningham
152	KD2MX	Paul Neuman
126	W2JEK	Donald C. Younger
123	N8RN	Roy Newman
123	KØLWV	Larry Mergen
119	W8TM	Paul Kirley
98	KØZK	Arnold Olean
97	WB3AAL	Ron Polityka
93	N2CQ	Ken Newman
87	K7TQ	Randy B. Foltz
81	WA5RML	Andrew Measday
73	W5KDJ	Wayne Rogers
73	K3OQ	Jeff Embry
64	K8DD	Hank Kohl
58	GM4XQJ	Brian Waddell
48	AB8FJ	Edwin "Ted" Albert
45	AA5CH	Brad Johnson
44	KD2JC	Joe Vrabel
44	K2EKM	Bill Gregory
41	NØEVH	John Watkins
34	K5ICW	Hank Lesesne
33	W1PID	Jim Cluett
33	VA3JFF	Jeff Hetherington
30	NG2T	Jeff Wildau
29	VE3EUR	Pat Byers
27	VO1BB	Bill Kirby
22	VA3CBE	Calvin Benoit
10	KF4UCC	George Tibbetts

Top Band Sprint Results								
Call	QTH	Score	QSOs	PWR	PTS	SPC	MULT	Rig + Ant
W4FMS	MI	44,982	62	< 5W	238	27	7	K2 + Inv L
W3TS	PA	28,800		< 1W	160	18	10	Ten Tec Orion + 1/8 wave wire tee
K3WW	PA	22,211	40	< 5W	167	19	7	
KØZK	ME	12,446	29	< 5W	127	14	7	K2 + 30ft Vertical
W2SH	NJ	11,921	28	< 5W	131	13	7	
AA4XX	NC	11,172		< 5W	114	14	7	K2 + 160m dipole, 160m folded vertical
W8RU	MI	8,330	20	< 5W	85	14	7	FT1000D + Inverted L
N8XI	MI	7917	18	< 5W	87	13	7	Ten Tec Omni V + Inv L
NØUR	MN	6,804	21	< 5W	81	12	7	FT920 + Inv L
NU4I	VA	6,300		< 5W	90	10	7	K2 + Inv L
WA1GWH	NY	5,180	17	< 5W	74	10	7	TS430S + 1/ wave wire against ground
K7RE	SD	4,690	17	< 5W	67	10	7	Flexradio SDR1000 + 45ft vertical
N4BP	FL	4340	16	< 5W	62	10	7	K3 + Inv L
KD2MX	NJ	3780	12	< 5W	60	9	7	FT897 + 650ft loop
KW4JS	TN	3,500	13	< 5W	50	10	7	Wilderness Sierra + Random Wire
WF4I	NC	3,332		< 5W	28	17	7	K2
KD2JC	NJ	3192		< 5W	57	8	7	K2 + 160m trap dipole
VE3MGY	ON	2,960	8	< 1W	37	8	10	
KN1H	NH	2730	13	< 5W	65	6	7	FT817
WD4LST	FL	2,142	12	< 5W	51	6	7	K2 + Inv L, 300ft Beverage
W2JEK	NJ	2,100	10	< 5W	50	6	7	FT840 + Marconi
KØJJR	MN	1,190		< 5W	34	5	7	Ten Tec Jupiter + Alpha Delta DXA Twin Sloper
AB4GK	GA	1,120	7	< 5W	32	5	7	IC746PRO + 80m horiz loop
WØUFO	MN	840	9	< 5W	24	5	7	FT897 + 120ft wire off centre fed
NIØC	MO	840		< 5W	24	5	7	K2 + Butternut Vertical HF-2V
KØLWV	MO	700	5	< 5W	25	4	7	FT757GXII + Bent Dipole up 30ft
AE3J	DE	630		< 5W	30	3	7	IC703 + 165ft Inv L
AB8FJ	OH	140	2	< 5W	10	2	7	Ten Tec Argo V + Random Wire
K3HX	PA	Checklog	44	> 5W	161	18	1	Orion I

mance as this seems, excellent operating from John L. Sielke, W2AGN, and Tim Colbert, K3HX, ensured that this competition came right down to the final contest of the year. John managed 213 QCC points and Tim 193 QCC points on the year. Great work guys, lets hope that the 2008 running is just as exciting.

Until next time, keep your power down and your QSO rates up.

—73/72, Jeff, VA3JFF

Top Band Sprint Soapbox Comments—

Didn't stay up too late, I wanted to be ready for a QRP effort in ARRL 160 contest. Had a new bad local line noise that caused some trouble with rxing.—**W3TS**

Started late and ended early.—**NØUR**

For the first 2.5 hours, I had big problems with my SDR-1000 and N1MMLogger causing freeze-ups which required reboots—very frustrating. My apologies to all who I dropped. I have never had this problem before, so that made the situation even more frustrating. I finally found the problem, a simple fix on the SDR software set up. Such is the price one pays for operating on the bleeding edge of technology. I didn't make a very high score but enjoyed it all immensely. I am always amazed at how well QRP does on 160m, a band where QRP is generally accepted to be anything below 200W!—**K7RE**

That was painful!—**N4BP**

Top Band Sprint Top 5 Results		
W4FMS	44,982	Frank Scutch
W3TS	28,800	Dana A. Michaels
K3WW	22,211	Charles D. Fulp Jr
KØZK	12,446	Arnold Olean
W2SH	11,921	Charles Moizeau

Holiday Spirits Homebrew Sprint Top 5 Results		
N4BP	261,525	Bob Patten
WØUFO	95,934	Mert Nellis
K8DDB	95,320	Mike Bray
K4BAI	89,628	John T. Lainey III
W3TS	86,240	Dana Michaels

Didn't have much time this year, but any amount of 160m QRP is a lot of fun.—**KD2MX**

Operated from QTH of AA4XX.—**WF4I**

The band was up and down at best. Condx will get better this winter.—**KD2JC**

My new GAP DSP Speaker helped a lot, 160 is a tough place for QRP.—**KØLWV**

Holiday Spirits Homebrew Sprint Soapbox Comments—

Conditions seemed quite good, and participation was good too so had a busy time. Need more activity on 80m, but I guess time was a factor.—**WØUFO**

Thanks, everyone, for a great contest. I called CQ on 160 meters for the last 15 minutes to no avail. Could have used the extra bonus points!—**K8DDB**

Fair conditions, although 40M seemed down a bit. Glad to work Mike, W3TS, on 160m for an extra 5000 points.—**W2AGN**

40m and 80m were good after 20m closed.—**K4ORD**

Holiday Spirits Homebrew Sprint Results

Call	QTH	Score	QSOs	PWR	PTS	Bands	SPC	MULT	Bonus	Rig + Ant
N4BP	FL	261,525	126	< 5W	525	ALL	63	7	30000	K3 + Cushcraft A4S, 40/80 Dipole, 160 Inv-L
WØUFO	MN	95,934	63	< 5W	282	ALL	41	7	15000	K2 + 40m inv vee, 80m 120ft wire, TA3
K8DDB	MI	95,320		< 5W	269	ALL	40	7	20000	Sierra + Triband, 40m dipole, 80m sloper
K4BAI	GA	89,628	66	< 5W	291	ALL	44	7	0	FT1000MP + TH6DXX, dipole, zepp, inv vee
W3TS	PA	86,240	45	< 1W	207	ALL	32	10	20000	K2 + 80/40 fan dipole
KØPC	MN	81,900	69	< 5W	300	ALL	39	7	0	IC-756 ProIII (I used the wrong rig!)
W2AGN	NJ	73,000	35	< 1W	160	ALL	30	10	25000	K2 + KT34, 300ft horiz loop
K4ORD	VA	69,974	53	< 5W	238	ALL	39	7	5000	K2 + 40m and 160m dipoles, 20m vee beam
VA3RKM	ON	64,963		< 5W	173	ALL	33	7	25000	K2 + Verticals and 80m dipole
AA4XX	NC	51,620		< 55mW	93	ALL	17	20	20000	Sierra + TH6, 40m wirebeam, 80m dipole
K4KSR	VA	42,176		< 5W	132	ALL	24	7	20000	K1 + Windom, Inv L
AI2T	NY	38,184	33	< 5W	138	ALL	24	7	15000	K1 and HW8
KN1H	NH	37,340	21	< 1W	102	ALL	17	10	20000	HB 6-Band VXO XMTR, HB 7-Band Superhet RCVR
N8RN	OH	32,864	25	< 5W	116	ALL	22	7	15000	K1 + 20m and 40m inv vee, 80m inv L
W5TVW	LA	31,528		< 5W	94	ALL	16	7	21000	HB 6T9 XMTR, HB Single Tube Regen Receiver
KD2MX	NJ	29,896	26	< 5W	112	ALL	19	7	15000	KX1 + 650ft loop at 30ft
KB3WK	MD	29,000	18	< 1W	75	ALL	12	10	20000	K2 + 3 ele yagi, dipoles
K3HX	PA	28,028	36	< 5W	143	ALL	28	7	0	Orion I + Homebrew Trap Dipole
W7GB	WA	22,423	31	< 5W	131	20	19	7	5000	K1 + 3 element StippIR
W2JEK	NJ	22,296	10	< 5W	41	ALL	8	7	20000	OHR500, LCK160 + Gnd plane on 20, dipole on 40
AD6GI	CA	19,956		< 5W	59	ALL	12	7	15000	K2 + Dipoles
KØZK/1	ME	19,500	10	< 1W	50	20/40	9	10	15000	NC20 and Rockmite 40 + 33ft Indoor Temp. Wire
N3AO	VA	18,295	17	< 5W	79	20/40	15	7	10000	KX1 + BigIR Ground Mounted Vertical
K5AM	NM	18,150	10	< 5W	50	ALL	9	7	15000	
KK5PJ	TX	17,688	10	< 5W	48	20/40	8	7	15000	K2 + MP1
KB9BVN	IN	17,154		< 5W	73	20/40	14	7	10000	K2 + Attic Dipole
KG1W	CT	15,752	21	< 5W	96	20/80	16	7	5000	K2, KX1
AA5TB	TX	14,072		< 5W	81	40	16	7	5000	SW-40+ + EFHW Inv-L
KD2MU	NY	14,004	11	< 5W	52	20/40	11	7	10000	K1
AA5CH	AR	13,850	11	< 5W	55	20/40	10	7	10000	K1 + Hex beam, centre fed zepp
WC4CW	ID	13,699	23	< 5W	103	20/40	19	7	0	
K2HYD	NC	13,276		< 5W	52	20/40	9	7	10000	KX-1 + Non-resonant doublet
K1GDH	MA	13,220	11	< 5W	46	40/80	10	7	10000	Heathkit HW9
KØLWV	MO	13,090	25	< 5W	110	20/40	17	7	0	Yaesu FT757 GXII + Longwire vee beam
KF4UCC	VA	10,420	4	< 5W	20	20/40	3	7	10000	Ten Tec Kit, Ventronics Xmtr
KC4ABC	FL	8,640	11	< 5W	52	20/40	10	7	5000	IC7000 + HVt-400 Vertical
WA5RML	TX	7,938		< 5W	81	20/40	14	7	0	Ten Tec Argo V + 20m vertical, 40m dipole
N8IE	OH	7,467		< 5W	71	40	11	7	2000	HB 6T9 Single Tube Xmtr
OK1MKX		5,700	7	< 1W	14	80	5	10	5000	SW80+ + Zepp up 20m
K2MEN	NJ	5,616	5	< 5W	22	20	4	7	5000	
WA1ZCQ/1	MA	5,420	4	< 5W	20	40/80	3	7	5000	IC703 + Phased Verticals
WB5FKC	TX	5,360	3	< 55mW	6	40	3	20	5000	HF Converter 40m, AM/DSB Receiver + Inv Vee
N8CX	OH	5,210		< 5W	15	40	2	7	5000	Emtech NW-40 + Dipole
AB8FJ	OH	5,140	2	< 5W	10	20	2	7	5000	SW20+ + Random Wire
VO1BB	NL	5,056	2	< 5W	4	20	2	7	5000	Heathkit SB102
KC2KME	NY	5,035	1	< 5W	5	40	1	7	5000	HB Phoenix QRP Transciever
AA2JZ	FL	4,312	13	< 5W	56	20	11	7	0	IC7000 + Heavy QRN on 20m
KA2KGP	NY	2,168	3	< 5W	12	40	2	7	2000	3W HB Xmtr, Argosy + 5 band Gnd Mounted Vert
VE3MGY	ON	1,800	6	< 1W	30	ALL	6	10	0	
VE3EUR	ON	875	5	< 5W	25	ALL	5	7	0	IC703 + 88ft doublet at 10m

Good conditions on the bands. Glad to work WØUFO on 3 bands but could not manage K4BAI and N4BP on 80m. A big storm dumped two feet of snow on Ottawa today, meaning lots of shoveling to do after the fun.—**VA3RKM**

Running 50 mW makes for a challenging contest, but it really puts the thrill back into the game. Thanks to all the great ears out there!—**AA4XX**

Sure glad I decided not to try portable operation.—**K4KSR**

I put my WH8 on the air to add 80m to my usual 40m and 20m, hoping to add a few points. It nearly doubled my score! Now if 15m opens up…—**AI2T**

I have more fun using the homebrew stuff than all my commercial gear combined. Hmmm.—**KN1H**

My first sprint since XYL came home from long hospital stay! Band conditions

Call	QTH	Score	QSOs	PWR	PTS	Bands	Grids	MULT	Rig + Ant
W2JEK	NJ	3,640	52	< 5W	52	50/144	10	7	Alinco DJ196, FT840 w/ TT 1208 transv + gnd plane 2m, Dipole 6m
N4BP	FL	3,552	111	< 10w	111	50	32	1	K3 + 3 element Homebrew Yagi
AA4XX	NC	154	11	< 5W	11	50	2	7	Argonaut II with TT 1208 Transverter + Dipole
N8QE	OH	120	24	> 10W	24	50/144	5	1	FT817 and FT2000 + gnd plane 2m, Stacked SQ50s for 6m
K3HX	PA	36	3	< 5W	3	50	3	4	IC706 + Dipole
VA3RKM	ON	14	2	< 5W	2	50	1	7	FT817 + 80m Dipole
VE3CW	ON	7	1	< 5W	1	50	1	7	FT817 + 2 element Hybrid Quad

VHF Contest Results

OK. Transmitter crystal controlled only. The 6T9'er runs about 4 watts output on 80/40/30 and less on 20 meters. Didn't have the time to spend the whole sprint, nor the inclination to setup outside with the Elecraft K1 this year.—**W5TVW**

Activity was pretty light and conditions seemed rather poor. Maybe it was the ice encasing my antenna. But still fun as always.—**KD2MX**

Early contest was slow going. Then just when the contest got going around 2230Z, my power went out. Murphy is alive and well!—**KB3WK**

Band very quiet, few stations on, good time however.—**K3HX**

Thanks for the fun sprint.—**W7GB**

Poor condx on 40—normally 40 is very busy.—**W2JEK**

Bands were gud in first hour, but deteriated too quick. Tnx to all those with gud ears and patience. Hope to cu nxt test.—**AD6GI**

VHF Contest Top 3 Results		
W2JEK	3,640	Donald C. Younger
N4BP	3,552	Bob Patten
AA4XX	154	Paul Stroud

I worked very hard on antenna system at home QTH for a few days before the contest, but heard bad WX reports so had a back-up station. Was stranded at apartment in Kennebunkport, Maine, with temporary 33ft wire antenna and NC20 and RM40.—**KØZK/1**

Fun and challenging. As usual, bands were weak with QRN.—**KK5PJ**

Bands were as usual....spent about 2 hours on Sprint...while watching football and staying out of the snow....life is good.—**KB9BVN**

I only got to operate for about 1.25 hours but I had a lot of fun. I had QSOs from Arkansas to Canada.—**AA5TB**

Not too many points, but fun, fun, fun!—**KD2MU**

Happy Holidays Everybody!—**KØLWV**

Operated portable from local park using auto battery power and small multi-band vertical lip-mounted on hood. Forced to leave the park just after 2300Z (6pm)—Staff closing up—just as 80m activity starting up!—**KC4ABC**

First chance to take my new call sign out for a spin.—**WA5RML** (ex WA3RML)

Ran my hombrew 6T9 single tube

Ten Questions with the 2007 QRP-ARCI Contest Champion

QQ: When were you first licensed?

N4BP: First licensed as WN1GIV in Wareham, MA, in 1955 at age 15. W1VFY, a crop duster and friend of my pilot father was my Elmer, now SK. Two years ago (50th anniversary), I reapplied for WN1GIV as the Plantation Contest Club.

QQ: What have been your primary operating interests?

N4BP: Been through many phases in my 50+ years, but contesting has been my primary interest for the past few.

QQ: What has been your most memorable contact?

N4BP: I can think of two off the top of my head. Years ago, I had a QSO with Yuri Gregarin, the Russian astronaut. More recently, and in line with QRP, worked 3B8CF running 50mW.

QQ: Describe your station set-up.

N4BP: I have two desks: QRO desk with new Elecraft K3 and AL-1500 amp. QRP desk with K2, K1, and KX1. Also IC-7000, mainly for 6M when on desk and not running mobile. The two desks have identical homebrew PCs running the N1MM Logger.

QQ: Tell us about your first foray into QRP.

N4BP: I didn't think of it as QRP at the time, but just after upgrading to W1GIV, I built a Heathkit VF-1 VFO to go with my Globe Chief transmitter. For a lark, I ran the VF-1 barefoot and made several Qs, probably under one watt output.

QQ: Why did you decide to join QRP-ARCI?

N4BP: At the time, I was tracking the various QRP awards offered by ARCI like WAS, DXCC, 1000 Miles per Watt, etc.

QQ: Tell us about your biggest QRP operating accomplishment to date.

N4BP: Made a 100% solar DXCC using a one amp panel directly powering an Argonaut 509, mostly on 10 Meters. It was actually kind of humorous at the time—when a cloud would obscure the sun, I was temporarily QRT.

QQ: What do your future QRP plans include?

N4BP: More contesting of course. Looking forward to the time when I can again run DX on 10 Meters. SFL is an ideal location for that activity.

QQ: What is the one piece of advice that you would give to QRP Contesters.

N4BP: Stay in the chair! You can't add to your Qs and Mults if you're not either CQing or searching for stations to work.

QQ: What is the one thing that you would suggest to improve QRP-ARCI Contests?

N4BP: Promote activity. I've seen a dramatic decrease in participation over the years. QRP participation in the major contests such as Sweepstakes seems to be healthy, but the ARCI contests are falling behind. Post announcements of upcoming sprints to your local club list—I do this from time to time on the Florida Contest Group list. ●●

Fireside SSB Sprint Results										
Call	QTH	Score	QSOs	PWR	PTS	Bands	SPC	MULT	Bonus	Rig + Ant
N4BP	FL	42,336	75	< 10W	216	20	28	7	0	FT100MP + Cushcraft A4S
AA4XX	NC	28,392	54	< 10W	156	10/20	26	7	0	Argonaut II + TH6DXX at 72ft
NDØC	MN	10,556		< 10W	116	20	13	7	0	Argonaut 509 + Wilson SY-3 Triband Yagi
K3OQ	MD	10,304		< 10W	92	15/20	16	7	0	K3 + Triband Yagi
VA3RKM	ON	5,560	4	< 10W	20	ALL	4	7	5000	K2 + 38ft wire
NJ1W	NJ	5,140	2	< 10W	10	20	2	7	5000	K2 + Homebrew PAC-12
KØLWV	MO	3,969	15	< 10W	63	20	9	7	0	FT787 GXII + Longwire Vee up 35ft
WA1WQG	CT	1,764	9	< 10W	36	40	7	7	0	Ten Tec 540 + Windom
N6DIT	CA	1,386	9	< 10W	33	ALL	6	7	0	TS50 + G5RV
AD7AN	CA	1,302	8	< 10W	31	20/40	6	7	0	Argonaut V + SteppIR Vertical
WB8LZG	MI	875	5	< 10W	25	20	5	7	0	FT817 + Dipole
ND4D	GA	875	5	< 10W	25	20	5	7	0	FT890
KC1FB	CT	770	5	< 10W	22	20/80	5	7	0	FT-7 + Butternut Butterfly Beam
KD2MU	NY	560	4	< 10W	20	20	4	7	0	Ten Tec Corsair + Dipole
KA2CAQ	NY	532	5	< 10W	19	20	4	7	0	Argonaut 509 + Dipole
N8QE	OH	98	2	< 10W	7	10	2	7	0	FT817 + Outbacker Joey
KB2HSH	NY	75	1	< 500mW	5	20	1	15	0	

XMTR and a Lionel J-38 hand key. I was rock bound on 7.040. This was a fun event and thanks to all!—**N8IE**

Unfortunately the conds were poor and only a few stations heard on 80m band. I hope to join next time when conds are better! Local industrial QRM was very high.—**OK1MKX**

Operated portable from the woods of Harvard, MA.—**WA1ZCQ/1**

Got in really late, but well worth it in spite of the noise.—**N8CX**

20m was good, but 40m was bad.—**VO1BB**

Tough reception with some international shortwave QRM earlier. I love making contacts with simple HB QRP equipment.—**KC2KME**

Used single band HB xcvr for first contact but needed to move to other bands so relinquished HB points by using my IC-703 for the remainder of the contest. Not much time available but managed 5 QSOs in yet another fun QRP-ARCI contest.—**VE3EUR**

VHF Contest Soapbox Comments—

First time on 6m with the new K3.—**N4BP**

KD4PBJ, N4HAY, and I enjoyed sharing a single station. We were running an Argonaut II and Ten Tec 1208 6M transverter at 5W output into a 6M dipole up 40 feet. We never caught a band opening but enjoyed working a number of stations in our grid square.—**AA4XX**

Sure am glad I'm not the only contester in Town. Thanks VE3RCN for my one QSO.—**VE3CW**

Fireside SSB Sprint Soapbox Comments—

My Argo V had badly distorted audio, so I switched over to the Argonaut II, which provided excellent audio reports. It was fun to actually get to hear what our fellow QRP'ers voices sound like after having worked a number of them in past CW-only contests. KF7ET gets the persistence award. It took us several attempts, but we finally completed the exchange. W7OM had an awesome, BIG signal. Pleasant surprises include AL7FS/Ø and VE5TLW. The most rewarding QSO was with Gary, N8GJK, who reported that this was his first ever QRP contact. Gary ended up throttling his rig down to 5W and was mightily impressed that he was still readily copiable. I think we may have a QRP convert on our hands.—**AA4XX**

Very tough going on this one. 20 was very flaky with severe QSB. Lost two multiplier QSOs (W3DA in Delaware and HC1HC) because they didn't respond to my request for their output power before their pile-ups swarmed them. Once again I surprised some high power guys with what 3 watts could do and a couple reduced their power to QRP levels and were amazed I could here them. Either there were fewer QRP stations on this year or maybe conditions were just so bad I couldn't hear many others.—**NDØC**

Conditions were not good. Only worked a NM station outside the local area. Used the temporary wire thrown into a tree that served for FYBO yesterday to get the snowdift bonus. It was a balmy 33 degrees and pleasant in the snow.—**VA3RKM**

Fireside SSB Sprint Top 5 Results		
N4BP	42,336	Bob Patten
AA4XX	28,392	Paul Stroud
NDØC	10,556	Randy Shirbroun
K3OQ	10,304	Jeff Embry
VA3RKM	5,560	Bob MacKenzie

Thanks for the contest. I had fun. QRM from nets very strong but it was clear around 14.290.—**KØLWV**

I usually don't play SSB, but had some spare time so I decided to give it a try. Heard many more stations than heard me, but I did work all around the USA: FL, NC, TX, ID and NM. Had lots of fun fer hamming without a key, hi hi! —**WB8LZG**

I was hoping to get my IC703 on the air for this contest; didn't happen. Big moment was contacting AL7FS ... in IA? —**KD2MU**

First contest & Superbowl Sunday. Wish I had more time.—**KA2CAQ**

It was nice to see 10m open for some E's contacts. Heard Argentina, but could not make the QSO.—**N8QE**

First QRP-ARCI Contest on 20 meters! Worked my first and only contact one minute into the contest. Could hear other stations, but they couldn't hear me.—**KB2HSH**

Contest Announcements

2008 QRP-ARCI Contest Schedule

April 5-6	Spring QSO Party
May 25	Hootowl Sprint
June 28-29	milliWatt Field Day Contest
July 13	Summer Homebrew Sprint
August 16	Silent Key Memorial Sprint
September 14	End of Summer Digital Sprint
October 18-19	Fall QSO Party
December 4	Top Band Sprint
December 21	Holiday Spirits Homebrew Sprint

For All Contests:

Entry forms and log submission procedures can be found at www.qrparci.org. Logs can be submitted by e-mail to contest@qrparci.org, or by postal mail to Jeff Hetherington, VA3JFF, QRP ARCI Contest Manager, (Contest Name), 139 Elizabeth St. W., Welland, Ontario, CANADA L3C 4M3. Submit Logs along with a summary stating your Callsign, Entry Category, Actual Power and Station Description along with score calculation.

Results:

Will be published in *QRP Quarterly* and shown on the QRP-ARCI Web site.

Certificates:

Will be awarded to the top scoring entrant in each category. Certificates may be awarded for 2nd and 3rd place if entries are sufficient in a category.

2008 Hootowl Sprint

Date/Time:

8pm to Midnight LOCAL TIME on 25 May 2008.

Objective:

To test your ability to make contacts late into the evening local time.

Mode:

HF CW only.

Exchange:

Members: RST, State/Province/Country, ARCI member #
Non-Members: RST, State/Province/Country, Power Out

QSO Points:

Member = 5 points/QSO
Non-Member, Different Continent = 4 points/QSO
Non-Member, Same Continent = 2 points/QSO

Multiplier:

SPC (State/Province/Country) total for all bands. The same station may be worked on multiple bands for QSO points and SPC credit.

Power Multiplier:

>5 watts = x1
>1 - 5 watts = x7
>250 mW - 1 watt = x10
>55 mW - 250 mW = x15
55 mW or less = x20

Suggested Frequencies:

160m	1810 kHz
80m	3560 kHz
40m	7030 kHz (please listen at 7040 kHz for rock bound participants)
20m	14060 kHz
15m	21060 kHz
10m	28060 kHz

Score:

Final Score = Points (total for all bands) x SPCs (total for all bands) x Power Multiplier + Bonus Points.

Bonus Points:

If you are operating PORTABLE using battery power AND a temporary antenna, add 5000 points to your final score. (You can NOT be at your shack operating from battery power using your home station antenna to qualify for this bonus.) This is to help level the playing field for contesters who work from the field against contest stations with 5 element yagis at 70 ft.

Categories:

Entry may be All-Band, Single Band, High Bands (10m-15m-20m) or Low Bands (40m-80m-160m)

How to Participate:

Get on any of the HF bands except the WARC bands and hang out near the QRP frequencies. Work as many stations calling CQ QRP or CQ TEST as possible, or call CQ QRP or CQ TEST yourself! You can work a station for credit once on each band.

Submissions:

Entries must be postmarked on or before 25 June 2008.

2008 milliWatt Field Day Contest

Date/Time:

1800Z on 28 June 2008 through 2100Z on 29 June 2008.

Bands:

All bands (HF & VHF+) as outlined in the ARRL Field Day Rules

Exchange:

Class/ARRL Section, per ARRL Field Day Rules

QSO Points:

CW = 2 points/QSO
SSB = 1 point/QSO
Digital = 2 points per QSO

Multiplier:

Use the lower power multiplier for the HIGHEST power you used in the contest.

Power Multiplier:

>5 watts = x1
>1 - 5 watts = x7

>250 mW - 1 watt = x10
>55 mW - 250 mW = x15
55 mW or less = x20

Score:
Final Score = Points (total for all bands) x ARRL Sections (total for all bands) x Power Multiplier.

Bonus Points:
There are NO bonus point for this contest.

Categories:
Class A: Club / non-club portable
Class B: One or two person portable
Class C: Mobile: Stations in vehicles capable of operating while in motion and normally operated in this manner
Class D: Home stations: Stations operating from licensed station locations using commercial power
Class E: Home stations—Emergency power
Class F: Emergency Operations Centers (EOC)

Best reason to participate:
A fun mixed mode QRP contest and a chance to test/prove emergency preparedness.

Submissions:
Entries must be postmarked on or before 29 July 2008.

2008 Summer Homebrew Sprint

Date/Time:
2000Z to 2359Z on 13 July 2008.

Mode:
HF CW Only.

Exchange:
Members: RST, State/Province/Country, ARCI member #
Non-Members: RST, State/Province/Country, Power Out

QSO Points:
Member = 5 points/QSO
Non-Member, Different Continent = 4 points/QSO
Non-Member, Same Continent = 2 points/QSO

Multiplier:
SPC (State/Province/Country) total for all bands. The same station may be worked on multiple bands for QSO points and SPC credit.

Power Multiplier:
>5 watts = x1
>1 - 5 watts = x7
>250 mW - 1 watt = x10
>55 mW - 250 mW = x15
55 mW or less = x20

Suggested Frequencies:

160m	1810 kHz
80m	3560 kHz
40m	7030 kHz (please listen at 7040 kHz for rock bound participants)
20m	14060 kHz
15m	21060 kHz
10m	28060 kHz

Score:
Final Score = Points (total for all bands) x SPCs (total for all bands) x Power Multiplier + Bonus Points.

Bonus Points:
For homebrew gear (per band) add 2,000 points for using HB transmitter; add 3,000 points for using HB receiver; or add 5,000 points for using HB transceiver. Definition of

The QRP-ARCI Contest Championship

The QRP-ARCI Contest Championship has been created in order to generate interest and participation among QRP operators in the contests sponsored by the QRP Amateur Radio Club International.

The QRP-ARCI Contest Championship (QCC) is operated concurrently with the regular contest offerings of the QRP-ARCI. Each operator that enters any of the contests listed below is automatically entered in the QCC. Please submit your entries to the below contests, no matter how small they may seem.

Eligible Contests: For 2008, the following 10 contests sponsored by QRP-ARCI will be eligible for the QCC. All contests count equally.

- VHF Contest
- Winter Fireside SSB Sprint
- HF Grid Square Sprint
- Spring QSO Party
- Hootowl Sprint
- Summer Homebrew Sprint
- Silent Key Memorial Sprint
- End of Summer Digital Sprint
- Fall QSO Party
- Holiday Spirits Homebrew Sprint

Scoring: Scoring for the QCC will be taken from the published results for each of the contests. The station placing first in each contest will receive a number of points equal to the average number of entrants in all of the QCC eligible contests from 2006. For the 2008 running of the QCC this number is 38. The station that places second will receive one less point, and so on, until either 1 point is reached, or the last entrant in the particular contest being scored is reached, whichever comes first. After that, zero points will be awarded for any additional entrants.

The final scores for the QCC will be the sum of the best six scores for each entrant. To be eligible for an award, an operator must enter at least three contests.

Awards: The person that is crowned as the QRP-ARCI Contest Championship Winner will be awarded a plaque suitable for hanging on their shack wall. Additional certificates will be awarded to the top scoring entrants in the championship.

Homebrew is any equipment built by you, either scratchbuilt or from a kit is acceptable.

If you are operating PORTABLE using battery power AND a temporary antenna, add 5,000 points to your final score. (You can NOT be at your shack operating from battery power using your home station antenna to qualify for this bonus.) This is to help level the playing field for contesters who work from the field against contest stations with 5 element yagis at 70 ft.

Categories:

Entry may be All-Band, Single Band, High Bands (10m-15m-20m) or Low Bands (40m-80m-160m)

How to Participate:

Get on any of the HF bands except the WARC bands and hang out near the QRP frequencies. Work as many stations calling CQ QRP or CQ TEST as possible, or call CQ QRP or CQ TEST yourself! You can work a station for credit once on each band.

Submissions:

Entries must be postmarked on or before 13 August 2008.

2008 Silent Key Memorial Sprint

Purpose:

Our contest celebrates and honors the QRP luminaries who no longer answer CQs. Those generous people who graciously donated to the QRP community their time, effort and knowledge to advance the premise that more fun could be had using less than 5 watts. Some were irascible and some were even considered curmudgeons, but when you took a keen look at their accomplishments and listened to those who knew them well you discovered truly wonderful people who would give you their last diode. The people we are celebrating are well known among the QRP Community. Some passed recently and some have enjoyed their reward many years. They are not forgotten for their accomplishments live on either on the bands, the internet, through published works or organizations that benefited from their largess. This contest celebrates ALL SKs who now call CQ from above, where all sigs are 599 and all contacts QSL 100%. Celebrate the many SKs that we have known and loved in years past.

Date/Time:

1500Z to 1800Z on 16 August 2008.

Mode:

CW Only

Exchange:

Members: RST, State/Province/Country, ARCI member #
Non-Members: RST, State/Province/Country, Power Out

QSO Points:

Member = 5 points/QSO
Non-Member, Different Continent = 4 points/QSO
Non-Member, Same Continent = 2 points/QSO

Multiplier:

SPC (State/Province/Country) total for all bands. The same station may be worked on multiple bands for QSO points and SPC credit.

Power Multiplier:

>5 watts = x1
>1 - 5 watts = x7
>250 mW - 1 watt = x10
>55 mW - 250 mW = x15
55 mW or less = x20

Suggested Frequencies:

160m	1810 kHz
80m	3560 kHz
40m	7030 kHz (please listen at 7040 kHz for rock bound participants)
20m	14060 kHz
15m	21060 kHz
10m	28060 kHz

Score:

Final Score = Points (total for all bands) x SPCs (total for all bands) x Power Multiplier + Bonus Points.

Bonus Points:

If you are operating PORTABLE using battery power AND a temporary antenna, add 5,000 points to your final score. (You can NOT be at your shack operating from battery power using your home station antenna to qualify for this bonus.) This is to help level the playing field for contesters who work from the field against contest stations with 5 element yagis at 70 ft.

Categories:

Entry may be All-Band, Single Band, High Bands (10m-15m-20m) or Low Bands (40m-80m-160m)

How to Participate:

Get on any of the HF bands except the WARC bands and hang out near the QRP frequencies. Work as many stations calling CQ QRP or CQ TEST as possible, or call CQ QRP or CQ TEST yourself! You can work a station for credit once on each band.

Submissions:

Entries must be postmarked on or before 16 September 2008.

2008 End Of Summer Digital Sprint

Date/Time:

2000Z to 2359Z on 14 September 2008.

Mode:

Any Digital Mode except CW. Stations may be worked once per band, regardless of mode.

Exchange:

Member = 5 points/QSO
Non-Member, Different Continent = 4 points/QSO
Non-Member, Same Continent = 2 points/QSO

Multiplier:

SPC (State/Province/Country) total for all bands. The same station may be worked on multiple bands for QSO points and SPC credit.

Power Multiplier:

>5 watts = x1
>1 - 5 watts = x7
>250 mW - 1 watt = x10
>55 mW - 250 mW = x15
55 mW or less = x20

Suggested Frequencies:

Check around the usual calling frequencies for the digital

mode of your choice.

Score:

Final Score = Points (total for all bands) x SPCs (total for all bands) x Power Multiplier + Bonus Points.

Bonus Points:

If you are operating PORTABLE using battery power AND a temporary antenna, add 5,000 points to your final score. (You can NOT be at your shack operating from battery power using your home station antenna to qualify for this bonus.) This is to help level the playing field for contesters who work from the field against contest stations with 5 element yagis at 70 ft.

Categories:

Entry may be All-Band, Single Band, High Bands (10m-15m-20m) or Low Bands (40m-80m-160m)

How to Participate:

Get on any of the HF bands except the WARC bands and hang out near the QRP frequencies. Work as many stations calling CQ QRP or CQ TEST as possible, or call CQ QRP or CQ TEST yourself! You can work a station for credit once on each band.

Submissions:

Entries must be postmarked on or before 14 October 2008.

FDIM 2008 XIII

Four Days in May
Thursday thru Sunday – May 15-18 2008

- Registration and getting acquainted begins Wednesday evening.
- Seminars are most of the day Thursday, with a "meet the speakers" and an open room for some casual show and tell and plenty of time to swap tales.
- Friday daytime is open to attend the Hamvention® and visit the QRP-ARCI Toy Store.
- Friday afternoon and evening activities usually include "show and tell", vendor displays and a judged home brew contest.
- Saturday is again open for the Hamvention, and we have a great social event, banquet, awards presentation and door prizes that evening.
- Sunday is the Hamvention, and checkout.

FDIM Registration and Hotel Reservation available on www.qrparci.org

Home Brew Contest	Build-a-thon
Banquet	Seminars
Meet the Speakers	Vendor Displays
Discounted QRP Products	Door Prizes
Discounted Hotel Rooms	Complimentary Breakfast
Hamvention just across town	Nearby Restaurants
New Product Announcements	Spouse Program

This is preliminary information. Some changes are likely to occur prior to the event.
Please check the web site, www.qrparci.org, for the latest details and registration information.

QRP ARCI STAFF

President
Dick Pascoe—GØBPS
Seaview House, Crete Road East,
Folkestone, Kent, CT18 7EG, UK
president@qrparci.org

Vice President, Acting Secretary
Ken Evans—W4DU
848 Valbrook Ct.
Lilburn, GA 30047
w4du@bellsouth.net

Treasurer, Membership/Subscriptions
Jack Nelson—K5FSE
1540 Stonehaven
Cumming, GA 30040
secretary@qrparci.org

Awards Manager
Jeff Embry—K3OQ
8650 Welbeck Way
Gaithersburg, MD 20886
awards@qrparci.org

Contest Manager
Jeff Hetherington—VA3JFF
139 Elizabeth Street West
Welland, ON L3C 4M3, CANADA
contest@qrparci.org

Webmaster
Steve Fletcher—G4GXL
43 Philip Rudd Court, Pott Row
Kings Lynn, Norfolk PE32 1WA, UK
webmaster@qrparci.org

BOARD OF DIRECTORS

Jay Bromley—W5JAY
3424Brooken Hill Dr.
Fort Smith, AR 72908
jayw5jay@cox.net

John Cumming—VE3JC
154 Guilford Crescent
London, ON N6J 3Y6, CANADA
jbcumming@sympatico.ca

Hank Kohl—K8DD
2130 Harrington Rd.,
Attica, MI 48412-9312
k8dd@arrl.net

Bill Kelsey—N8ET
3521 Spring Lake Dr.
Findlay, OH 45840
kanga@bright.net

Ed Hare—W1RFI
304 George Washington TPKE
Burlington, CT 06013
w1rfi@arrl.org

Steve Fletcher—G4GXL
43 Philip Rudd Court, Pott Row
Kings Lynn, Norfolk PE32 1WA, UK
webmaster@qrparci.org

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http://www.qrparci.org/lookup.html

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http://www.qrparci.org/us2signup.html

and follow the instructions. Be sure to select the appropriate button for the area of the world you reside in (US, Canada, or DX). International members may send payment by check directly to the club Treasurer, but ... ***funds must be drawn on a U.S. bank and be in U.S. dollars.*** Make checks payable to: **QRP ARCI**.

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QRP ARCI
Jack Nelson, K5FSE
1540 Stonehaven
Cumming, GA 30040

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